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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 217

[Docket No. 221214-0271]

RIN 0648-BL52

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to the Revolution Wind Offshore Wind Farm Project Offshore Rhode Island

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Proposed rule; proposed incidental take regulations; proposed letter of authorization; request for comments.

SUMMARY: NMFS has received a request from Revolution Wind, LLC (Revolution Wind), a 50/50 joint venture between Ørsted North America, Inc. (Ørsted) and Eversource Investment, LLC, for Incidental Take Regulations (ITR) and an associated Letter of Authorization (LOA). The requested regulations would govern the authorization of take, by Level A harassment and/or Level B harassment, of small numbers of marine mammals over the course of 5 years (2023-2028) incidental to construction of the Revolution Wind Offshore Wind Farm Project offshore of Rhode Island in a designated lease area on the Outer Continental Shelf (OCS-A-0486), within the Rhode Island-Massachusetts Wind Energy Area (RI/MA WEA). Project activities likely to result in incidental take include pile driving (impact and vibratory), potential unexploded ordnance (UXO/MEC) detonation, and vessel-based site assessment surveys using high-resolution geophysical (HRG) equipment. NMFS requests comments on its proposed rule. NMFS will consider public comments prior to making any final decision on the

promulgation of the requested ITR and issuance of the LOA; agency responses to public comments will be summarized in the final notice of our decision. The proposed regulations would be effective October 5, 2023 - October 4, 2028.

DATES: Comments and information must be received no later than [*insert date 30 days after date of publication in the FEDERAL REGISTER*].

ADDRESSES: Submit all electronic public comments via the Federal e-Rulemaking Portal. Go to *www.regulations.gov* and enter NOAA-NMFS-2022-0127 in the Search box. Click on the "Comment" icon, complete the required fields, and enter or attach your comments.

Instructions: Comments sent by any other method, to any other address or individual, or received after the end of the comment period, may not be considered by NMFS. All comments received are a part of the public record and will generally be posted for public viewing on *www.regulations.gov* without change. All personal identifying information (*e.g.*, name, address), confidential business information, or otherwise sensitive information submitted voluntarily by the sender will be publicly accessible. NMFS will accept anonymous comments (enter ''N/A'' in the required fields if you wish to remain anonymous). Attachments to electronic comments will be accepted in Microsoft Word, Excel, or Adobe PDF file formats only.

FOR FURTHER INFORMATION CONTACT: Carter Esch, Office of Protected Resources, NMFS, (301) 427-8401.

SUPPLEMENTARY INFORMATION:

Availability

A copy of Revolution Wind's application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.* In case of problems accessing these documents, please call the contact listed above (see **FOR FURTHER INFORMATION CONTACT**).

Purpose and Need for Regulatory Action

This proposed rule would provide a framework under authority of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 *et seq*.) to allow for the authorization of take of marine mammals incidental to construction of the Revolution Wind Farm Project within the Bureau of Ocean Energy Management (BOEM) Renewable Energy lease area OCS-A 0486 and along export cable corridors to landfall locations in Rhode Island. NMFS received a request from Revolution Wind for 5-year regulations and a Letter of Authorization (LOA) that would authorize take of individuals of four species of marine mammals by Level A harassment and Level B harassment and 12 species by only Level B harassment incidental to Revolution Wind's construction activities. No mortality or serious injury is anticipated or proposed for authorization. Please see the *Legal Authority for the Proposed Action* section below for definitions of harassment.

Legal Authority for the Proposed Action

The MMPA prohibits the "take" of marine mammals, with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq*.) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made, regulations are promulgated, and public notice and an opportunity for public comment are provided.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other “means of effecting the least practicable adverse impact” on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for taking for certain subsistence uses (referred to as “mitigation”); and requirements pertaining to the mitigation, monitoring and reporting of the takings are set forth. The definitions of all applicable MMPA statutory terms cited above are included below.

Section 101(a)(5)(A) of the MMPA and the implementing regulations at 50 CFR part 216, subpart I, provide the legal basis for proposing and, if appropriate, issuing this rule containing 5-year regulations and associated LOA. This proposed rule also establishes required mitigation, monitoring, and reporting requirements for Revolution Wind’s activities.

Summary of Major Provisions within the Proposed Rule

The major provisions of this proposed rule include:

- Establishing a seasonal moratorium on impact pile driving during the months of highest North Atlantic right whale (*Eubalaena glacialis*) presence in the project area (January 1 – April 30);
- Establishing a seasonal moratorium on any unexploded ordnances or munitions and explosives of concern (UXOs/MECs) detonations during the months of highest North Atlantic right whale present in the project area (January 1 – April 30).
- Requiring that any UXO/MEC detonations may only occur during hours of daylight and not during hours of darkness or nighttime.
- Conducting both visual and passive acoustic monitoring by trained, NOAA Fisheries-approved Protected Species Observers (PSOs) and Passive Acoustic Monitoring (PAM) operators before, during, and after the in-water construction activities;
- Requiring the use of sound attenuation device(s) during all impact pile driving and UXO/MEC detonations to reduce noise levels;

- Delaying the start of pile driving if a North Atlantic right whale is observed at any distance by the PSO on the pile driving or dedicated PSO vessels;
- Delaying the start of pile driving if other marine mammals are observed entering or within their respective clearance zones;
- Shutting down pile driving (if feasible) if a North Atlantic right whale is observed or if other marine mammals enter their respective shutdown zones;
- Implementing soft starts for impact pile driving and using the lowest hammer energy possible;
- Implementing ramp-up for high-resolution geophysical (HRG) site characterization survey equipment;
- Requiring PSOs to continue to monitor for 30 minutes after any impact pile driving occurs and for any and all UXO/MEC detonations;
- Increasing awareness of North Atlantic right whale presence through monitoring of the appropriate networks and VHF Channel 16, as well as reporting any sightings to the sighting network;
- Implementing numerous vessel strike avoidance measures;
- A requirement to implement noise abatement system(s) during all impact pile driving and UXO/MEC detonations;
- Sound field verification requirements during impact pile driving and UXO/MEC detonation to measure in situ noise levels for comparison against the model results; and
- Removing gear from the water during fisheries monitoring research surveys if marine mammals are considered at-risk or are interacting with gear.

Under Section 105(a)(1) of the MMPA, failure to comply with these requirements or any other requirements in a regulation or permit implementing the MMPA may result in civil monetary penalties. Pursuant to 50 CFR 216.106, violations may also result in suspension or withdrawal of the Letter of Authorization (LOA) for the project. Knowing violations may result in criminal penalties, under Section 105(b) of the MMPA.

National Environmental Policy Act (NEPA)

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq*.) and NOAA Administrative Order (NAO) 216-6A, NMFS must evaluate the proposed action (*i.e.*, promulgation of regulations and subsequent issuance of a 5-year LOA) and alternatives with respect to potential impacts on the human environment.

Accordingly, NMFS proposes to adopt BOEM's Environmental Impact Statement (EIS), provided our independent evaluation of the document finds that it includes adequate information analyzing the effects of promulgating the proposed regulations and LOA issuance on the human environment. NMFS is a cooperating agency on BOEM's EIS. BOEM's draft EIS (Revolution Wind Draft Environmental Impact Statement (DEIS) for Commercial Wind Lease OCS-A 0486) was made available for public comment on September 2, 2022 (87 FR 54248), beginning the 45-day comment period ending on October 17, 2022. Additionally, BOEM held three in-person public hearings on October 4, 2022, in Aquinnah, MA, October 5, 2022, in East Greenwich, CT, and October 6, 2022, in New Bedford, MA, and two virtual public hearings on September 29 and October 11, 2022.

Information contained within Revolution Wind's incidental take authorization (ITA) application and this **Federal Register** document collectively provide the environmental information related to these proposed regulations and associated 5-year LOA for public review and comment. NMFS will review all comments submitted in response to this document prior to concluding the NEPA process or making a final decision on the requested 5-year ITA and LOA.

Fixing America's Surface Transportation Act (FAST-41)

This project is covered under Title 41 of the Fixing America's Surface Transportation Act, or "FAST-41". FAST-41 includes a suite of provisions designed to expedite the environmental review for covered infrastructure projects, including enhanced interagency coordination as well as milestone tracking on the public-facing Permitting Dashboard. FAST-41 also places a 2-year limitations period on any judicial claim that challenges the validity of a Federal agency decision to issue or deny an authorization for a FAST-41 covered project. 42 U.S.C. 4370m-6(a)(1)(A).

Revolution Wind's proposed project is listed on the Permitting Dashboard, where milestones and schedules related to the environmental review and permitting for the project can be found: *https://www.permits.performance.gov/permitting-projects/revolution-wind-farm-project*.

Summary of Request

On October 8, 2021, Revolution Wind submitted a request for the promulgation of regulations and issuance of an associated 5-year LOA to take marine mammals incidental to construction activities associated with implementation of the Revolution Wind Offshore Wind Farm Project (herein "the Project") offshore of Rhode Island, in the BOEM lease area OCS-A-0486.

Revolution Wind's request is for the incidental, but not intentional, taking of a small number of 16 marine mammal species (comprising 16 stocks) by Level A harassment (for four species or stocks) and Level B harassment (for all 16 species or stocks). Neither Revolution Wind nor NMFS expects serious injury or mortality to result from the specified activities based on the implementation of various mitigation measures as described below in the **Proposed Mitigation** section.

In response to our questions and comments, and following extensive information exchange between Revolution Wind and NMFS, we received subsequent revised applications and/or supplementary materials on January 24, 2022, and February 11, 2022. Revolution Wind submitted a final version of the application on February 23, 2022, which NMFS deemed adequate and complete on February 28, 2022. This final application is available on NMFS' website at: *https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy*.

On March 21, 2022, a notice of receipt (NOR) of the application was published in the **Federal Register** (87 FR 15942), requesting comments and soliciting information related to Revolution Wind's request during a 30-day public comment period. During the NOR public comment period, NMFS received 27 substantive comments from two environmental non-governmental organizations (ENGO) Oceana and the Rhode Island Saltwater Anglers Association (RISSA). NMFS has reviewed all submitted material and has taken these into consideration during the drafting of this proposed rulemaking. Subsequently, in June 2022, new scientific information was released regarding marine mammal densities (Robert and Halpin, 2022) and, as such, Revolution Wind submitted an Updated Density and Take Estimation Memo in August that included updated marine mammal densities and take estimates. NMFS posted this memo on the NMFS website on August 26, 2022.

NMFS previously issued four Incidental Harassment Authorizations (IHAs) to Ørsted for the taking of marine mammals incidental to marine site characterization surveys (using HRG equipment) of the Revolution Wind's BOEM lease area (OCS-A 0486) and surrounding BOEM lease areas (OCS-A 0487, OCS-A 0500) (see 84 FR 52464, October 2, 2019; 85 FR 63508, October 8 14, 2020; 87 FR 756, January 6, 2022; and 87 FR 61575, October 12, 2022). To date, Ørsted has complied with all IHA requirements (*e.g.*, mitigation, monitoring, and reporting). Information regarding Ørsted's monitoring results may be found in the **Estimated Take** section, and the full monitoring reports can be found on NMFS' website: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.*

On August 1, 2022, NMFS announced proposed changes to the existing North Atlantic right whale vessel speed regulations to further reduce the likelihood of mortalities and serious injuries to endangered right whales from vessel collisions, which are a leading cause of the species' decline and a primary factor in an ongoing Unusual Mortality Event (87 FR 46921). Should a final vessel speed rule be issued and become effective during the effective period of this ITA (or any other MMPA incidental take authorization), the authorization holder would be required to comply with any and all applicable requirements contained within the final rule. Specifically, where measures in any final vessel speed rule are more protective or restrictive than those in this or any other MMPA authorization, authorization holders would be required to comply with the requirements of the rule. Alternatively, where measures in this or any other MMPA authorization are more restrictive or protective than those in any final vessel speed rule, the measures in the MMPA authorization would remain in place. The responsibility to comply with the applicable requirements of any vessel speed rule would become effective immediately upon the effective date of any final vessel speed rule and, when notice is published of the effective date, NMFS would also notify Revolution Wind if the measures in the speed rule were to supersede any of the measures in the MMPA authorization such that they were no longer required.

Description of the Specified Activity

Overview

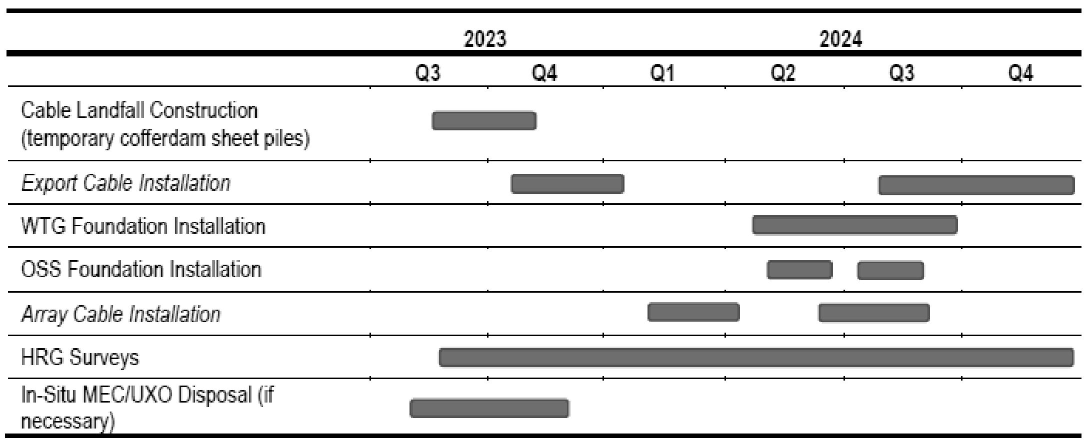
Revolution Wind has proposed to construct and operate a 704 megawatt (MW) wind energy facility (known as Revolution Wind) in State and Federal waters in the Atlantic Ocean in lease area OCS-A-0486, which would provide power to Rhode Island

and Connecticut. Revolution Wind's project would consist of several different types of permanent offshore infrastructure, including wind turbine generators (WTGs; *e.g.*, Siemens Gamesa 11 megawatt (MW)) and associated foundations, offshore substations (OSS), offshore substation array cables, and substation interconnector cables. In their application, Revolution Wind indicated they plan to install up to 100 WTGs and two offshore substations (OSS) via impact pile driving; the temporary installation and removal of two cofferdams to assist in the installation of the export cable route by vibratory pile driving; several types of fishery and ecological monitoring surveys; the placement of scour protection; trenching, laying, and burial activities associated with the installation of the export cable route from OSSs to shore-based converter stations and inter-array cables between turbines; HRG vessel-based site characterization surveys using active acoustic sources with frequencies of less than 180 kilohertz (kHz); and the potential detonation of up to 13 UXO/MECs of different charge weights, as necessary. Vessels would transit within the project area, and between ports and the wind farm to transport crew, supplies, and materials to support pile installation. All offshore cables would connect to onshore export cables, substations, and grid connections, which would be located at Quonset Point in North Kingstown, Rhode Island.

Since submission of the application, Revolution Wind has re-evaluated previous survey data and analyzed additional survey data. On October 13, 2022, Revolution Wind informed NMFS that 21 of the 100 WTG positions are not able to be developed due to installation infeasibility. On November 8, 2022, Revolution Wind provided NMFS with a Reduced WTG Foundation Scenario memo that includes revised exposure and take estimates based on the installation of 79 WTG foundations; therefore, for purposes of this proposed rule, we are analyzing take requests associated with the installation of the reduced number of foundations (*i.e.*, 79 WTG foundations plus two OSS foundations, for a total of 81 foundations). In addition, the amount of trackline within the lease area that would be surveyed using HRG equipment has been reduced to reflect the shorter overall distance of inter-array cables that would be required for 79 rather than 100 WTG foundations. Revolution Wind now estimates that they would survey 9,559 km over 136.6 days rather than 11,600 km over 165.7 days during construction (Year 1) in the lease area. Following construction (*i.e*., in Years 2-5), Revolution Wind now plans to survey 2,117 km over 30.2 days per year rather than 2,640 km over 37.7 days per year in the lease area. The amount of survey work that would be conducted in the export cable corridor would not change from what was included in the ITR application, despite installation of fewer WTG foundations. Marine mammals exposed to elevated noise levels during impact and vibratory pile driving, potential detonations of UXOs, or site characterization surveys, may be taken, by Level A harassment and/or Level B harassment, depending on the specified activity.

Dates and Duration

Revolution Wind anticipates that activities with the potential to result in harassment of marine mammals would occur throughout all five years of the proposed regulations which, if promulgated, would be effective from October 5, 2023, through October 4, 2028. Installation of monopile foundations, cable landfall construction, and UXO/MEC detonations in the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC) corridor would occur over approximately 12 to 18 months, from the third quarter (Q3) of 2023 to the fourth quarter (Q4) of 2024 (Figure 1). Through the end of the 5-year effective period of the requested regulations in Q3 2028, HRG surveys could take place within the RWF and RWEC at any time of year; the timeframe for these post-construction surveys is not included in Figure 1. The general construction schedule in Figure 1 and Table 1 presents all of the major project components, including those that may result in take, and those from which incidental take is not expected (*i.e.*, components in italics in Figure 1 and Table 1).



1 - Project components in italics are not expected to result in take.
2 - HRG surveys would occur throughout the LOA's 5-year effective period, through Q3 2028.

Figure 1. Revolution Wind's General Proposed Construction Schedule[1,2]

Table 1. Revolution Wind's Construction and Operations Schedule.[1]

Project Area	Project Component	Expected Duration and Timing
RWF Construction	WTG foundation installation	~ 5 months Q2 - Q3 2024
	OSS foundation installation	~ 2 – 3 days Q2 - Q3 2024
	Array cable installation	~ 5 months Q1 - Q3 2024
	HRG surveys	Any time of year Q3 2023 - Q4 2024
	In situ UXO/MEC disposal	~ up to 7 days Q3 - Q4 2023
RWEC Construction	Cable landfall installation (temporary cofferdam or casing pipe installation and removal	~ up to 56 days Q3 - Q4 2023
	Offshore export cable installation	~ 8 months Q4 2023 – Q4 2024
	HRG surveys	Any time of year Q3 2023 – Q4 2024
	In situ UXO/MEC disposal	~ up to 6 days Q3 – Q4 2023
Operations	HRG surveys	Any time of year Q4 2024 – Q3 2028

1 - Project components in italics are not expected to result in take.

WTG and OSS Pile Installation (Impact Pile Driving)

The installation of 79 WTG and 2 OSS monopiles foundations would be limited to May through December, given the seasonal restriction on impact pile driving in the RWF from January 1-April 30. As described previously, Revolution Wind intends to install all monopile foundations in a single year. However, it is possible that monopile installation would continue into a second year, depending on construction logistics and local and environmental conditions that may influence Revolution Wind's ability to maintain the planned construction schedule.

Installation of a single WTG monopile foundation is expected to require a maximum of 4 hours of active impact hammering, which can occur either in a continuous 4-hour interval or intermittently over a longer time period. For the purposes of acoustic modeling, it was assumed that installation of a single WTG monopile would require a total of 10,740 hammer strikes over 220 minutes (3.7 hours). Revolution Wind assumes that a maximum of three WTG monopile foundations can be driven into the seabed per day, although fewer installations per day may occur depending on logistics and environmental conditions. Installation of each of the two OSS monopile foundations is expected to require a larger number of hammer strikes (11,564) over a longer period (380 minutes, or 6.3 hours), given that the OSS monopile foundation is larger in diameter than the WTG monopile foundation. Revolution Wind has requested 24-hour pile driving, which would consist of intermittent impact pile driving that could occur anytime within a 24-hour timeframe, amounting to a maximum of 12 hours of active pile driving per day to install up to three monopiles. No concurrent impact pile driving (*i.e.*, installing multiple piles at the same time) is planned for this project.

Revolution Wind anticipates that the first WTG would become operational in Q2 of 2024, after installation is completed and all necessary components, such as array cables, OSSs, export cable routes, and onshore substations are installed. Turbines would be commissioned individually by personnel on location, so the number of commissioning teams would dictate how quickly the process would be achieved. Revolution Wind expects that all turbines would be commissioned by Q4 2024.

Potential UXO/MEC detonations

Revolution Wind anticipates encountering the potential presence of UXOs/MECs in and around the project area during the 5 years of the proposed rule. These UXOs/MECs are defined as explosive munitions (*e.g.*, shells, mines, bombs, torpedoes, *etc.*) that did not explode or detonate when they were originally deployed or that were intentionally discarded to avoid detonations on land. Typically, these munitions could be left behind following Navy military training, testing, or operations. Revolution Wind primarily plans for avoidance or relocation of any UXOs/MECs found within the project area, when possible. In some cases, it may also be possible that the UXO/MEC could be cut up to extract the explosive components. However, Revolution Wind notes this may not be possible in all cases and in situ disposal may be required. If in situ disposal is required, all disposals would be performed using low-order methods (deflagration), which are considered less impactful to marine mammals, first and then would be elevated up to high-order removal (detonation), if this approach is determined to be necessary. In the event that high-order removal is needed, all detonations would only occur during daylight hours.

Based on preliminary survey data, Revolution Wind conservatively estimates a maximum of 13 days on which UXO/MEC detonation may occur, with up to one UXO/MEC being detonated per day and a maximum of 13 UXOs/MECs being detonated over the entire 5-year period. NMFS notes that UXOs/MECs may be detonated from May through November in any year; however, no UXOs/MECs would be detonated in Federal waters between December 1 and April 30 of any year during the effective period of the proposed rule.

Cable Landfall Construction

Cable landfall construction is one of the first activities scheduled to occur, sometime within the Q3 2023 to Q4 2023 timeframe. Installation of the RWEC landfall would be accomplished using a horizontal directional drilling (HDD) methodology. The drilling equipment would be located onshore and used to create a borehole, one for each cable, from shore to an exit point on the seafloor approximately 250 m (800 ft) offshore. At the seaward exit site for each borehole, construction activities may include a casing pipe scenario, which involves the temporary installation of two casing pipes, each supported by sheet pile goal posts, to collect drilling mud from the borehole exit point. Alternatively, two temporary cofferdams may be installed to create a dry environment from which drilling mud could be collected. Each cofferdam, if required, may be installed as either a sheet-piled structure into the seafloor or a gravity cell cofferdam placed on the seafloor using ballast weight. Only one of these three landfall construction alternatives (*i.e.*, casing pipe scenario, sheet pile cofferdam, or gravity cell cofferdam) would be installed.

Casing Pipe Installation and Removal

The casing pipes would each require up to 3 hours per day of pneumatic impact hammering to install, over a period of two days for each pipe (6 hours total over 4 days for both), depending on the number of pauses required to weld additional sections onto the casing pipe. Removal of the casing pipe would also involve the use of a pneumatic pipe ramming tool, but the pipe would be pulled out of the seabed while hammering was occurring instead of being pushed into it. The same total of 4 days of pneumatic hammering (6 hours total), may be required for removal of both pipes.

Up to six goal posts may be installed to support each casing pipe (12 goal posts total), which would be located between a barge and the penetration point on the seabed. Each goal post would be composed of two vertical sheet piles installed using a vibratory hammer such as an American Piledriving Equipment (APE) model 300 (or similar). A horizontal cross beam connecting the two sheet piles would then be installed to provide support to the casing pipe. For each casing pipe, installation of six goal posts would require up to three days total of vibratory pile driving, or up to 6 days total for both casing pipes. Removal of the goal posts would also involve the use of a vibratory hammer and would likely require approximately the same amount of time as installation (6 days total for both casing pipes). Thus, use of a vibratory pile driver to install and remove the 12 goal posts may occur on up to 12 days at the landfall location.

Cofferdam Installation and Removal

If Revolution Wind selects this alternative, installation of two 50 m x 10 m x 3 m (164 ft x 33 ft x 10 ft) sheet pile cofferdams at the cable landfall construction location near Quonset Point in Kingstown, Rhode Island, may require up to 14 days of vibratory pile driving per cofferdam (28 days total). After the sheet piles are installed, the inside of each cofferdam would be excavated to approximately 10 ft (3 m). Once HDD operations are complete and the cables installed, the cofferdams would be removed, using vibratory hammering, over the course of up to 14 days per cofferdam. Separate cofferdams would be installed and removed for each of the two export cable bundles, amounting to up to 56 days of vibratory hammering at the landfall location.

If Revolution Wind decides to install the gravity cell cofferdam (which would have the same approximate dimensions as the sheet pile cofferdam), the structure would be fabricated onshore, transported to the site on a barge, and then lifted off the barge and placed on the seafloor using a crane. This process would not involve pile driving or other underwater sound producing activities, and is not expected to result in harassment of marine mammals.

Revolution Wind anticipates that impacts from cofferdam installation and removal using sheet piles would exceed any potential impacts for the use of alternative methods (*i.e.*, gravity cell cofferdam, casing pipe scenario), and therefore the cofferdam estimates using the sheet pile approach ensures that the most conservative values are carried forward in analyses for this proposed action.

HRG Surveys

High-resolution geophysical site characterization surveys would occur annually throughout the 5 years the rule and LOA would be effective. The specific duration would be dependent on the activities occurring in that year (*i.e.*, construction versus non-construction year). HRG surveys would utilize up to a maximum of four vessels working concurrently in different sections of the lease area and RWEC corridor. During the first year of construction (when the majority of foundations and cables would be installed), Revolution Wind estimates that 9,669 km would be surveyed over 136.6 days in the lease area, and 5,748 km would be surveyed along the RWEC corridor over 82.1 days, in water depths ranging from 2 m (6.5 ft) to 50 m (164 ft). During non-construction years (the final 4 years in which the regulations and LOA would be effective), Revolution Wind estimates 2,117 km would be surveyed in the lease area over 30.2 days and 1,642 km would be surveyed over 23.5 days along the RWEC corridor each year. Revolution Wind anticipates that each vessel would survey an average of 70 km (44 miles) per day, assuming a 4 km/hour (2.16 knots) vessel speed and 24-hour operations. Each day that a survey vessel covers 70 km (44 miles) of survey trackline is considered a vessel day. For example, Revolution Wind would consider 2 vessels operating concurrently, with each surveying 70 km (44 miles), two vessel days. In some cases, vessels may conduct daylight-only 12-hour nearshore surveys, covering half that distance (35 km or 22 miles). Over the course of 5 years, HRG surveys would be conducted at any time of year for a total of 30,343 km (18,854 miles) over 433.5 vessel days. In this schedule, Revolution Wind accounted for periods of down-time due to inclement weather or technical malfunctions.

Specific Geographic Region

Revolution Wind would install the RWF in Federal waters within the designated lease area OCS-A 0486 (Figure 2). The 339 square kilometer (km^2) (83,798 acres) lease area is located within the 1,036 km^2 (256,000 acres) RI/MA WEA. The edge of the lease area closest to land is approximately 15 mi (13 nm, 24 km) southeast of the Rhode Island coast. The RWEC corridor would traverse both federal waters and state territorial waters of Rhode Island, extending up to approximately 50 mi (80 km) from the RWF to the RWEC landfall location at Quonset Point in North Kingstown, Rhode Island. Two temporary cofferdams or casing pipes (with associated goal posts) would be installed at Quonset Point to facilitate the sea-to-shore transition for the export cables. Water depths in the lease area range from 24 to 50 m (78.7 to 164.0 ft), averaging 35 m (114.8 ft), while water depths along the RWEC corridor range from 10 to 45 m (32.8 to 147.6 ft). The cable landfall construction area would be approximately 15 m (49.2 ft) in depth.

Revolution Wind's specified activities would occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem (NES LME), an area of approximately 260,000 km^2 from Cape Hatteras in the south to the Gulf of Maine in the north. Specifically, the lease area and cable corridor are located within the Mid-Atlantic Bight subarea of the NE LME which extends between Cape Hatteras, North Carolina, and Martha's Vineyard, Massachusetts, extending eastward into the Atlantic to the 100-m isobath. In the Middle Atlantic Bight, the pattern of sediment distribution is relatively simple. The continental shelf south of New England is broad and flat, dominated by fine grained sediments. Most of the surficial sediments on the continental shelf are sands and gravel. Silts and clays predominate at and beyond the shelf edge, with most of the slope being 70-100 percent mud. Fine sediments are also common in the shelf valleys leading to the submarine canyons, as well as in areas such as the "Mud Patch" south of Rhode Island. There are some larger materials, including boulders and rocks, left on the seabed by retreating glaciers, along the coast of Long Island and to the north and east, including in Rhode Island Sound near where the Revolution Wind lease area is located.

In support of the Rhode Island Ocean Special Area Management Plan development process, Codiga and Ullman (2011) reviewed and summarized the physical oceanography of coastal waters off Rhode Island. Conditions off the coast of Rhode Island are shaped by a complex interplay among wind-driven variability, tidal processes, and density gradients that arise from combined effects of interaction with adjacent estuaries, solar heating, and heat flux through the air-sea interface. In winter and fall, the stratification is minimal and circulation is a weak upwelling pattern, directed offshore at shallow depths and onshore near the seafloor; in spring and summer, strong stratification develops due to an important temperature contribution, and a system of more distinct currents occurs. These include the southern New England shelf flow westward along the offshore area, which bifurcates in the east where a portion moves northward as the RIS Current, a narrow flow that proceeds counterclockwise around the perimeter of RIS, likely in association with a tidal mixing front.

The Revolution Wind lease area, located on Cox Ledge, is dominated by complex habitats that support diverse assemblages of fish and invertebrates. Large contiguous areas of complex habitats are located centrally and throughout the entire southern portion of the lease area. Smaller, patchy areas of complex habitats also occur throughout the northern portion of the lease area. Biogeographic patterns in Rhode Island Sound are persistent from year to year, yet variable by season, reflected by the cross-shelf migration of fish and invertebrate species in the spring and fall (Malek *et al*., 2014).

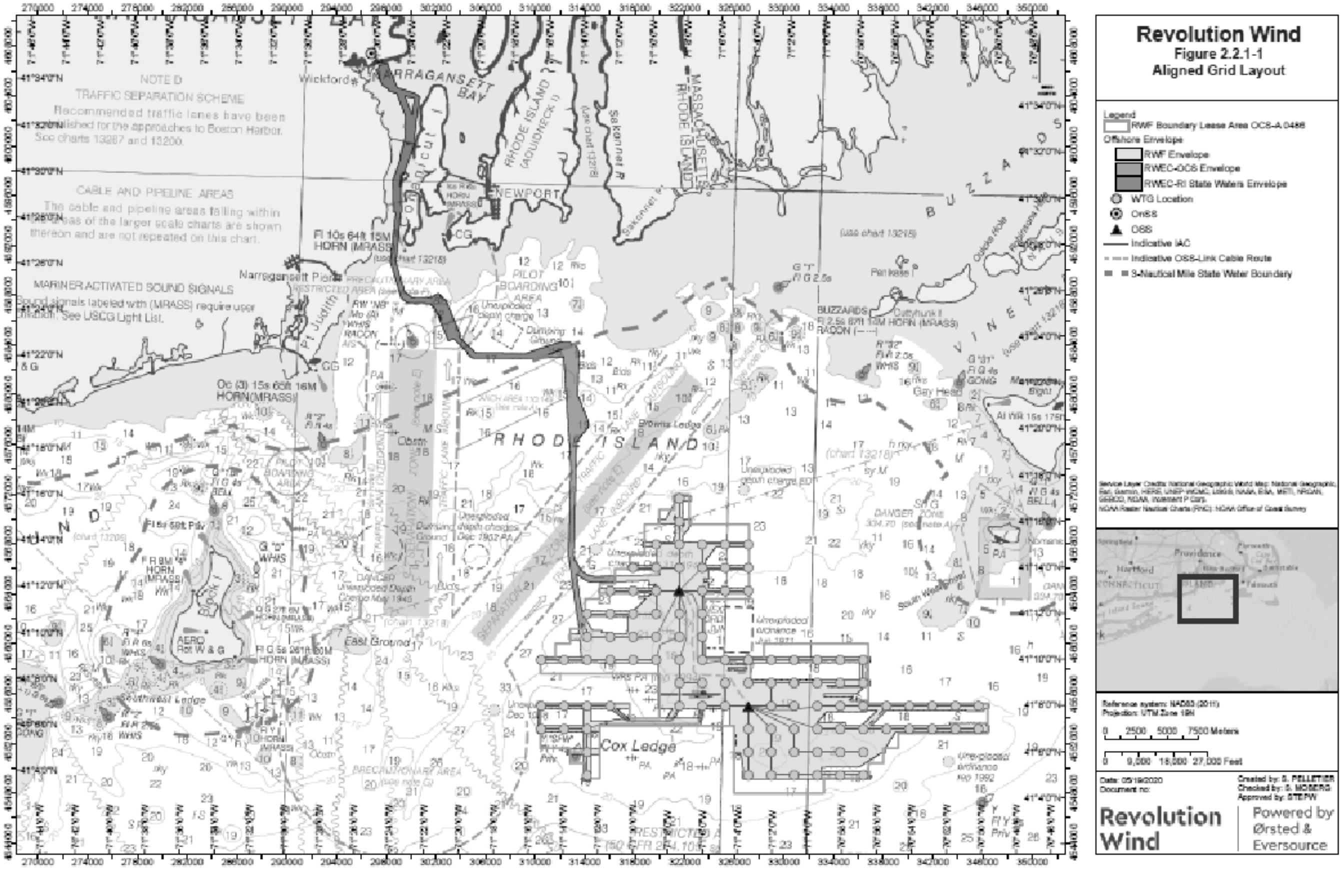


Figure 2. Location of Lease Area OCS-A 0486, Revolution Wind Offshore Wind Farm and Export Cable Routes.

Detailed Description of Specific Activity

Below, we provide detailed descriptions of Revolution Wind's activities, explicitly noting those that are anticipated to result in the take of marine mammals and for which incidental take authorization is requested. Additionally, a brief explanation is provided for those activities that are not expected to result in the take of marine mammals.

Installation of WTG and OSS Monopile Foundations

Revolution Wind plans to install 81 monopile foundations over approximately one year within the 5-year effective period of the proposed rule. To do so, they would use impact pile driving, which is expected to result in the incidental take of marine mammals. Pile driving would be limited to the months of May through December, annually, and would primarily occur in Year 1 (and potentially Year 2, should significant schedule delays occur). Monopiles are the only foundation type proposed for the project. As mentioned previously, the 81 monopiles installed to support the 79 WTG and two OSSs would have a maximum diameter of 12 m (39.4 ft) and 15 m (49.2 ft), respectively, and would be driven to a maximum penetration depth of 50 m (164 ft) using an IHC-4000 kilojoules (kJ) impact hammer. The monopiles are tapered such that the top diameter is 7 m (for both WTG and OSS foundations), the bottom diameter is 12-m (WTG) or 15-m (OSS), with both sizes tapering near the water line (referred to as 7/12-m and 7/15-m monopiles herein).

A monopile foundation typically consists of a single steel tubular section, with several sections of rolled steel plate welded together. Schematic diagrams showing potential heights and dimensions of the various components of a monopile foundation are shown in Figures 3 and 4 of Revolution Wind's ITA application.

A typical monopile installation sequence begins with the monopiles being transported directly to the lease area for installation, or to the construction staging port by an installation vessel or a feeding barge. At the foundation installation location, the main installation vessel (heavy lift, or jack-up vessel) upends the monopile in a vertical position in the pile gripper mounted on the side of the vessel. The gripper frame, depending upon its design, may be placed on the seabed scour protection materials to stabilize the monopile's vertical alignment before and during piling. Scour protection is included to protect the foundation from scour development, which is the removal of the sediments near structures by hydrodynamic forces, and consists of the placement of stone or rock material around the foundation. Once the monopile is lowered to the seabed, a temporary steel cap called a helmet would be placed on top of the pile to minimize damage to the head during impact driving. The hydraulic impact hammer is then lifted on top of the pile to commence pile driving with a soft start (see **Proposed Mitigation** section). The largest impact hammer Revolution Wind expects to use for driving monopiles produces up to 4,000 kJ of energy, however, the required energy to install a monopile may ultimately be far less than 4,000 kJ. The intensity (*i.e.*, hammer energy level) of impact hammering would be gradually increased based on resistance from the sediments (see **Estimated Take** for the potential hammer schedule and strike rate).

Pile installation would occur during daylight hours and could continue into nighttime hours if pile installation is started 1.5 hours prior to civil sunset. Alternatively, if Revolution Wind submits an Alternative Monitoring Plan (as part of the Pile Driving and Marine Mammal Monitoring Plan) that reliably demonstrates to NMFS that Revolution Wind can effectively visually and acoustically monitor marine mammals during nighttime hours, they may initiate pile driving during night (see **Proposed Mitigation** section). If NMFS approves Revolution Wind's plan and allows pile driving to occur at night, Revolution Wind plans to install three monopiles per day although, given logistical constraints (*e.g.*, sea state limitations for impact pile driving, weather) and the coordination required, it is possible that fewer than three monopiles would be installed per day.

It is estimated that a single foundation installation sequence would require up to approximately nine hours (one hour pre-start clearance, up to four hours of pile driving, and four hours to move to the next location). Again, no concurrent impact pile driving would occur, regardless of the number of piles installed per day. Once construction begins, Revolution Wind would proceed as rapidly as possible, while meeting all required mitigation and monitoring measures, to reduce the total duration of construction such that work is condensed into summer months when right whale occurrence is expected to be lowest in the project area.

UXO/MEC Detonations

Revolution Wind anticipates the potential for construction activities to encounter UXO/MECs on the seabed within the RWF and along the RWEC corridor. The risk of incidental detonation associated with conducting seabed-altering activities such as cable laying and foundation installation in proximity to UXO/MECs jeopardizes the health and safety of project participants (Revolution Wind 2022). Revolution Wind follows an industry standard As Low as Reasonably Practicable (ALARP) process that minimizes the number of potential detonations (Construction and Operations Plan (COP) Appendix G; Revolution-Wind 2022). For UXO/MECs that are positively identified on the seabed in proximity to planned activities, several alternative strategies would be considered prior to in-situ UXO/MEC disposal. These may include 1) relocating the activity away from the UXO/MEC (avoidance), 2) moving the UXO/MEC away from the activity (lift and shift), 3) cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or 4) using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration)

(Revolution Wind 2022). Only after these alternatives are considered would in-situ high-order UXO/MEC detonation be pursued. To detonate a UXO/MEC, a small charge would be placed on the UXO/MEC and ignited, causing the UXO/MEC to then detonate, which could result in the taking of marine mammals.

To better assess the potential UXO/MEC encounter risk, HRG surveys have been and continue to be conducted to identify potential UXO/MECs that have not been previously mapped. As these surveys and analysis of data from them are still underway, the exact number and type of UXO/MECs in the project area are not yet known. As a conservative approach for the purposes of the impact analysis, Revolution Wind assumed that up to 13 UXO/MEC 454-kg (1000 pounds; lbs) charges (up to seven UXO/MECs in the RWF and up to six UXO/MECs along the RWEC corridor), which is the largest charge that is reasonably expected to be encountered, may require in situ detonation. Although it is highly unlikely that all 13 charges would weigh 454 kg, this approach was determined to be the most conservative for the purposes of impact analysis. If necessary, these detonations would occur on up to 13 different days (*i.e.*, only one detonation would occur per day). In the event that high-order removal (detonation) is determined to be the preferred and safest method of disposal, all detonations would occur during daylight hours. UXO/MEC detonations would be prohibited from December 1 through April 30 to provide protection for right whales during the timeframe they are expected to occur more frequently in the project area.

Export Cable Landfall Construction

Once construction plans are completed, Revolution Wind would determine whether to install gravity cell cofferdam, sheet pile cofferdams, or the casing pipe scenario. Again, only installation of the latter two alternatives are expected to result in the take of marine mammals. As mentioned previously, the amount of take incidental to installation of the casing pipe alternative is expected to be less than or equal to, and occur over a much shorter duration than, that from installation of sheet pile cofferdams. Installation of sheet pile cofferdams (described below) was carried forward in the take estimation analyses, given the large size of the Level B harassment zone and the longer duration of the activity (see **Estimated Take** section). Compared to the sheet pile cofferdam alternative, installation of the casing pipe, described below, produced larger Level A harassment (SEL_{cum}) zones due to the high hammering rate required for the relatively small hammer to install the pipe. The potential for Level A harassment incidental to casing pipe installation is higher than it is for cofferdam installation, assuming a marine mammal remains within the relevant Level A harassment zone for the duration of the installation. However, the short duration of required pneumatic hammering (see below) coupled with implementation of Revolution Wind's proposed mitigation and monitoring measures (*i.e.*, shutdown zones equivalent to the size of the casing pipe Level A harassment zones) would decrease the likelihood of Level A harassment to the extent that neither Revolution Wind nor NMFS anticipates it would occur, nor is it proposed for authorization.

Installation and Removal of Casing Pipes

Installation of two casing pipes would be completed using pneumatic pipe ramming equipment, while installation of sheet piles for goal posts would be completed using a vibratory pile driving hammer (previously described). Casing pipe and sheet pile installations would not occur simultaneously, and would be limited to daylight hours.

The casing pipe would be installed at a slight upward angle relative to the seabed so that the pipe creates a straight alignment between the point of penetration at the seabed and the construction barge. Casing pipe installation would occur from the construction barge and be accomplished using a pneumatic pipe ramming tool (Gundoram Taurus or similar) with a hammer energy of up to 18 kJ. If necessary, additional sections of casing pipe may be welded together on the barge to extend the length of the casing pipe from the barge to the penetration depth in the seabed. As mentioned previously, installation of each casing pipe would require up to 3 hours per day of pneumatic hammering for 2 days, for a total of 6 hours per pipe. Removal of each casing pipe may require use of the pneumatic hammering tool (during which the pipe is pulled from the seabed) for the same amount of time as installation (3 hours of pneumatic hammering for 2 days for each casing pipe; total of 6 hours per pipe).

Up to six goal posts would be installed for each casing pipe, for a total of twelve goal posts. As described previously, each goal post would be composed of 2 vertical sheet piles installed using a vibratory hammer with a horizontal cross beam connecting the two sheet piles. Up to 10 additional sheet piles may be installed per casing pipe to help anchor the barge and support the construction activities. This results in a total of up to 22 sheet piles per casing pipe, for a total of 44 sheet piles to support both casing pipes. Sheet piles used for the goal posts and supports would be up to 30 m (100 ft) long, 0.6 m (2 ft) wide, and 1 inch thick. Installation of the goal posts would require up to 3 days per casing pipe, or up to 6 days total for both casing pipes. Removal of the goal posts would also involve the use of a vibratory hammer and likely require approximately the same amount of time as installation (6 days total for both casing pipes). Thus, use of a vibratory pile driver to install and remove sheet piles may occur on up to 12 days at the landfall location. All of the sheet pile goal posts would be installed first, followed by installation of the casing pipe.

Installation and Removal of Temporary Cofferdams

As an alternative to the casing pipe/goal post scenario described above, two cofferdams may be installed to allow for a dry environment during construction and manage sediment, contaminated soil, and bentonite (drilling mud used during HDD operations). If required, the cofferdams may be installed as either a sheet-piled structure (driven into the sea floor) or a gravity cell cofferdam placed on the seafloor using ballast weight. Regardless of the type of structure, the cofferdams could each measure up to 50 m x 10 m x 3 m (164 ft x 33 ft x 10 ft). If a gravity cell cofferdam was selected for installation, the structure would be fabricated onshore, transported to the site on a barge, and then lifted off the barge and placed on the seafloor using a crane. This process would not involve pile driving or other underwater sound producing activities so is not carried forward into take analyses. Given that the design process for the HDD is still ongoing, Revolution Wind is not able to commit to a particular landfall construction scenario. As the design matures, Revolution Wind would refine the appropriate HDD export cable landfall methodology based on site conditions and state permit requirements.

If cofferdams are installed using sheet piles, a vibratory hammer such as an APE model 200T (or similar) would be used to drive sheet piles of up to 30 m (100 ft) long, 0.6 m (2 ft) wide, and 1 inch thick. The sidewalls and endwall would be driven to a depth of up to 30 ft (9.1 m); sections of the shore-side endwall would be driven to a depth of up to 6 ft (1.8 m) to facilitate the borehole entering underneath the endwall. Installation of each sheet pile cofferdam may take up to 14 days, as would removal, for a total of 28 days per cofferdam or 56 days of vibratory hammer use (installation and removal) for both cofferdams.

HRG Surveys

HRG surveys would be conducted to identify any seabed debris, and to support micro-siting of the WTG and OSP foundations and cable routes. These surveys may utilize active acoustic equipment such as multibeam echosounders, side scan sonars, shallow penetration sub-bottom profilers (SBPs) (*e.g.*, Compressed High-Intensity Radiated Pulses (CHIRPs) non-parametric SBP), medium penetration sub-bottom profilers (*e.g.*, sparkers and boomers), ultra-short baseline positioning equipment, and marine magnetometers, some of which are expected to result in the take of marine mammals. Surveys would occur annually, with durations dependent on the activities occurring in that year (*i.e.,* construction year versus a non-construction year).

As summarized previously, HRG surveys would be conducted using up to four vessels to survey the RWF and RWEC corridor 12-24 hours/day for a total of 345.8 vessel days, operating at any time of the year over the course of five years. On average, 70-line km would be surveyed per vessel each vessel day at approximately 4 km/hour (2.16 knots). Two 12-hr surveys covering 35 km/per day each would count as one vessel day because one complete vessel day is defined by the total kilometers surveyed (*i.e.*,70 km). While the final survey plans would not be completed until construction contracting commences, approximately 50 percent (218.7 days; 15,307 km (9,511 miles)) of the total survey effort would occur during the construction phase (2023-2024). During non-construction periods, an estimated 3,759 km (2,336 miles) would be surveyed over 53.7 days each year in the RWF and along the RWEC corridor. The purpose of surveying during construction years is to monitor installation activities, provide third-party verification of contractor's work, and assess seabed levels pre-, during, and post-seabed disturbing activities. The purpose of surveying during non-construction years is to monitor seabed levels and scour protection, identify any risks to inter-array and export cable integrity, and conduct seabed clearance surveys prior to maintenance/repair.

Of the HRG equipment types proposed for use, the following have the potential to result in take:

- Shallow penetration sub-bottom profilers (SBPs) to map the near-surface stratigraphy (top 0 to 5 m (0 to 16 ft) of sediment below seabed). A CHIRP system emits sonar pulses that increase in frequency over time. The pulse length frequency range can be adjusted to meet project variables. These are typically mounted on the hull of the vessel or from a side pole.

- Medium penetration SBPs (boomers) to map deeper subsurface stratigraphy as needed. A boomer is a broad-band sound source operating in the 3.5 Hz to 10 kHz frequency range. This system is typically mounted on a sled and towed behind the vessel.
- Medium penetration SBPs (sparkers) to map deeper subsurface stratigraphy as needed. A sparker creates acoustic pulses from 50 Hz to 4 kHz omni-directionally from the source that can penetrate several hundred meters into the seafloor. These are typically towed behind the vessel with adjacent hydrophone arrays to receive the return signals.

Table 2 identifies all the representative survey equipment that operates below 180 kilohertz (kHz) (*i.e.,* at frequencies that are audible and have the potential to disturb marine mammals) that may be used in support of planned HRG survey activities, and are likely to be detected by marine mammals given the source level, frequency, and beamwidth of the equipment. Equipment with operating frequencies above 180 kHz (*e.g.*, side-scan sonar (SSS), multibeam echosounder (MBES)) and equipment that does not have an acoustic output (*e.g.*, magnetometer) would also be used, but are not discussed further because they are outside the general hearing range of marine mammals likely to occur in the project area. No harassment exposures can be reasonably expected from the operation of these sources; therefore, they are not considered further in this proposed action.

Table 2. Summary of representative HRG Survey equipment

Equipment Type	Representative Model	Operating Frequency (kHz)	Source Level SPL_{rms} (dB)	Source Level 0-pk (dB)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Information Source
Sub-bottom Profiler	EdgeTech 216	2 – 16	195	-	20	6	24	MAN
	EdgeTech 424	4 – 24	176	-	3.4	2	71	CF
	Edgetech 512	0.7 – 12	179	-	9	8	80	CF
	GeoPulse 5430A	2 – 17	196	-	50	10	55	MAN
	Teledyn Benthos CHIRP III - TTV 170	2 – 17	197	-	60	15	100	MAN
Sparker	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	0.3 – 1.2	203	211	1.1	4	Omni	CF
Boomer	Applied Acoustics triple plate S-Boom (700–1,000 J)	0.1 – 5	205	211	0.6	4	80	CF

- = not applicable; ET = EdgeTech; J = joule; kHz = kilohertz; dB = decibels; SL = source level; UHD = ultra-high definition; AA = Applied Acoustics; rms = root-mean square; µPa = microPascals; re = referenced to; SPL = sound pressure level; PK = zero-to-peak pressure level; Omni = omnidirectional source.

a - The Dura-spark measurements and specifications provided in Crocker and Fratantonio (2016) were used for all sparker systems proposed for the survey. These include variants of the Dura-spark sparker system and various configurations of the GeoMarine Geo-Source sparker system. The data provided in Crocker and Fratantonio (2016) represent the most applicable data for similar sparker systems with comparable operating methods and settings when manufacturer or other reliable measurements are not available.

b - Crocker and Fratantonio (2016) provide S-Boom measurements using two different power sources (CSP–D700 and CSP–N). The CSP–D700 power source was used in the 700 J measurements but not in the 1,000 J measurements. The CSP–N source was measured for both 700 J and 1,000 J operations but resulted in a lower SL; therefore, the single maximum SL value was used for both operational levels of the S-Boom.

Vessel Activity

During construction and development of the project, associated vessels would slightly increase the volume of traffic in the project area, particularly during the first 12-18 months throughout construction of the RWF and installation of the RWEC. The largest size vessels are expected during the monopile installation phase, with floating/jack-up crane barges, DP-equipped cable laying vessels, and associated tugs and barges transporting construction equipment and materials. Up to 60 vessels may be utilized for construction across various components of the Project including installation of the foundations, WTGs, OSSs, inter-array cables, and OSS-Link Cable (Revolution Wind COP Table 3.3-26; Revolution-Wind 2022). The types of vessels Revolution Wind anticipates using during construction activities and operations, as well as the anticipated number of vessels and vessel trips, are summarized in Tables 3 and 4. The actual number of vessels involved in the Project at one time is highly dependent on the final schedule, the final impacts of boulder clearance and in situ UXO/MEC disposal, the final design of the Project's components, and the logistics needed to ensure compliance with the Jones Act, a Federal law that regulates maritime commerce in the U.S (Revolution Wind, 2022).

During construction, the Project would involve the use of temporary construction areas and construction ports. Revolution Wind is considering multiple port locations and any combination of the ports under consideration may be utilized. The ports that may be used during construction are as follows:

- Construction Hub: Port of Montauk (New York), Port Jefferson (New York), Port of Brooklyn (New York), Port of Davisville and Quonset Point (Rhode Island), and/or Port of Galilee (Rhode Island).

- Foundation Marshaling and Advanced Foundation Component Fabrication: Port of Providence (Rhode Island), Paulsboro Marine Terminal (New Jersey), and/or Sparrows Point (Maryland).
- WTG Tower, Nacelle, and Blade Storage, Pre-commissioning, and Marshalling: Port of Providence (Rhode Island), Port of New London (Connecticut), Port of Norfolk (Virginia), and/or New Bedford Marine Commerce Terminal (Massachusetts).
- Electrical Components: Port of Providence (Rhode Island).

Vessels not transporting material from the ports listed above may travel with components and equipment directly to the lease area from locations such as the Gulf of Mexico, Europe, or other worldwide ports. Before arriving at the lease area, a port call for inspections, crew transfers and bunkering may occur (Revolution Wind 2022).

Construction vessel traffic would result in a relatively localized impact which would occur sporadically throughout the approximate 18-month time period of offshore construction in and around the RWF, temporarily increasing the volume and movement of vessels. Large work vessels for foundation and WTG installation would generally transit to the lease area and remain in the area until installation is complete. These large vessels would move slowly over a short distance between work locations within the lease area. Crew transport vessels would travel between several ports and the RWF over the course of the construction period following mandatory vessel speed restrictions, as described in the **Proposed Mitigation** section below. These vessels would range in size from smaller crew transport vessels, to tug and barge vessels. However, Revolution Wind has confirmed that construction crews would hotel onboard installation vessels at sea, thus limiting the number of crew vessel transits expected (870 round-trips during the construction and 300 round trips during non-construction years) during the effective period of the proposed rule.

Vessels would comply with NMFS' regulations and state regulations as applicable for North Atlantic right whales (hereinafter "right whale," or "right whales") and additional measures included in this proposed rule. The total number of estimated round trips for all vessels during the construction (scheduled for Year 1) and non-construction years (Year 2-5) is 1,406 and 444, respectively.

Table 3. Type and Number of Vessels, and Number of Vessel Trips, Anticipated during Construction (scheduled for Year 1)

Vessel Types	Number of Vessels	Number of Return Trips Per Vessel Type
Wind Turbine Foundation Installation		
Heavy Lift Installation Vessel	1	1
?Heavy Lift Installation Vessel (secondary steel)	1	1
Towing Tug (for fuel barge)	1	10
Anchor Handling Tug	2	50
Vessel for Bubble Curtain	1	20
Heavy Transport Vessel	4	25
Crew Transport Vessel	1	30
PSO Vessel	4	80
Platform Supply Vessel (secondary steel)	2	65.
Platform Supply Vessel (completions)	1	20
Fall Pipe Vessel	1	6
Turbine Installation		
Jack-up Installation Vessel	1	20
Fuel Bunkering Vessel	1	8
Towing Tug (for fuel barge)	1	8
Array Cable Installation		
Pre-Lay Grapnel Run	1	4
Boulder Clearance Vessel	1	10
Sandwave Clearance Vessel	1	2
Cable Laying Vessel	1	6
Cable Burial Vessel	1	6
Crew Transport Vessel	1	231
Walk to Work Vessel (SOV)	1	6
Survey Vessel	1	8
DP2 Construction Vessel	1	5
OSS Topside Installation		
Heavy Transport Vessel	1	1
Offshore Export Cable Installation		
Pre-Lay Grapel Run	1	2
Boulder Clearance Vessel	1	3
Sandwave Clearance Vessel	1	1
Cable Lay and Burial Vessel	1	5

Cable Burial Vessel-Remedial	1	1
Cable Lay Barge	1	3
Tug – Small Capacity	2	3
Tug – Large Capacity	1	8
Crew Transport Vessel	1	214
Guard Vessel/Scout Vessel	5	8
Survey Vessel	1	3
DP2 Construction Vessel	1	3
Supply Barge	1	4
All Construction Activities[1]		
Safety Vessel	2	100
Crew Transport Vessel	3	395
Supply Vessel	1	30
Service Operation Vessel	1	1
Helicopter	1	76

1 - The vessels included in the "All Construction Activities" section provide general support across all of the activities in Table 3. The vessels listed in each activity (e.g., "Wind Turbine Foundation Installation" are solely utilized for that activity.

Table 4. Type and Number of Vessels, and Number of Vessel Trips, Anticipated during Scheduled Operations and Maintenance Activities (Years 2-5)

Vessel Type	Number of Vessels	Number of Return Trips Per Vessel Type Per Year	Total Number of Return Trips for Years 2-5
Service Operation Vessel	1	26	104
Crew Transport Vessel	1	62	248
Shared Crew Transport Vessel	0.5	13	52
Daughter Craft	1	10	40

While marine mammals are known to respond to vessel noise and the presence of vessels in different ways, we do not expect Revolution Wind's vessel operations to result in the take of marine mammals. As existing vessel traffic in the vicinity of the project area off Rhode Island and Massachusetts is relatively high, we expect that marine mammals in the area are likely somewhat habituated to vessel noise. In addition, any construction vessels would be stationary for significant periods of time when on-site and any large vessels would travel to and from the site at relatively low speeds. Project-related vessels would be required to adhere to mitigation measures designed to reduce the potential for marine mammals to be struck by vessels associated with the project; these measures are described further below (see the **Proposed Mitigation** section). Given the implementation of these measures, vessel strikes are neither anticipated nor proposed to be authorized (see *Potential Effects of Vessel Strike* section).

As part of various vessel-based construction activities, including cable laying and construction material delivery, dynamic positioning thrusters may be utilized to hold vessels in position or move slowly. Sound produced through use of dynamic positioning thrusters is similar to that produced by transiting vessels, and dynamic positioning thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Sound produced by dynamic positioning thrusters would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for harassment. Construction-related vessel activity, including the use of dynamic positioning thrusters, is not expected to result in take of marine mammals and Revolution Wind did not request, and NMFS does not propose to authorize, any take associated with construction vessel activity. However, NMFS acknowledges the aggregate impacts of Revolution Wind's vessel operations on the acoustic habitat of marine mammals and has considered it in the analysis.

Revolution Wind has also included the potential use of an Autonomous Surface Vehicle (ASVs), a small unmanned surface vessel or platform, during HRG surveys. Should an ASV be utilized during surveys, it would be positioned within 800 m (2,625 ft) of the primary vessel while conducting survey operations, operated at a slow speed, and would be monitored by PSOs at all times. Revolution Wind did not request take specific to ASVs and NMFS is not proposing to authorize take associated with ASV operation.

Fisheries and Benthic Habitat Monitoring

As described in section 1.1.7 of Revolution Wind's ITA application, the fisheries and benthic monitoring efforts Revolution Wind plans to conduct throughout the proposed rule's period of effectiveness have been designed for the Project in accordance with recommendations set forth in "Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf" (BOEM 2019). In particular, Revolution Wind's Fisheries and Benthic Monitoring Plan includes four elements: trawl surveys, an acoustic telemetry study, ventless trap surveys, and benthic habitat monitoring. Trawl surveys would be focused on sampling the fish and invertebrate community within the Project area. For the acoustic telemetry study, Highly Migratory Species (bluefin tuna, shortfin mako, and blue sharks) would be tagged during the trawl survey, after which Revolution Wind would use a combination of fixed station receivers and active mobile telemetry to assess the movements of these species. Revolution Wind would deploy up to 100 additional acoustic tags opportunistically for cod caught as part of trawl survey. The ventless trap survey would be conducted twice per month between May and November to investigate the relative abundance of lobster, Jonah crab, and rock crab. Ten trap trawls (6 ventless and 4 vented) would be fished on a five-day soak time. Finally, hard bottom habitat monitoring would occur, during which Revolution Wind would use a remotely operated vehicle (ROV) and video surveying approach to characterize changes from pre-construction conditions. Soft bottom habitat monitoring would be conducted using Sediment Profile and Plan View Imaging (SPI/PV) to document physical (and biological change related to construction of the Project. Because the gear types and equipment used for the acoustic telemetry study and benthic habitat monitoring do not have components with which marine mammals are likely to interact (*i.e.*, become entangled in or hooked by), these activities are unlikely to have any impacts on marine mammals.

Of the activities described, trawl and ventless trap surveys could have the potential to impact marine mammals through interactions with fishing gear (*i.e.*, entanglement). However, Revolution Wind has proposed, and would be required, to implement Best

Management Practices (BMPs) that would minimize this risk to the degree that take of marine mammals is not reasonably anticipated. Given these BMPs (included in the **Proposed Mitigation** section), neither NMFS nor Revolution Wind anticipates that any take is likely to occur incidental to the activities described herein and in section 1.1.7 of the ITA application (Revolution Wind, 2021). Additionally, Revolution Wind has not requested any take of marine mammals incidental to fisheries surveys and benthic habitat monitoring, nor does NMFS propose to authorize any take given the nature of the activities and, for certain gear types, Revolution Wind's planned mitigation measures. Therefore, aside from the mitigation measures provided in the **Proposed Mitigation** section, these activities are not analyzed further in this document.

Dredging

Dredging may be used to remove materials from the seafloor in preparation of offshore foundation and export cable locations. There are two fundamental types of dredging that could be used by the Project – mechanical and hydraulic. Mechanical dredging refers to crane-operated buckets, grabs (clamshell), or backhoes used to remove seafloor material. Hydraulic (suction) dredging and controlled flow excavation (CFE) dredging involve the use of a suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. There are a variety of hydraulic and CFE dredge types including trailing suction, cutter-suction, auger suction, jet-lift, and air-lift (Kusel *et al*., 2021). The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump.

NMFS does not expect dredging to generate noise levels that would cause take of marine mammals. Most of the acoustic energy produced by dredging falls below 1 kHz, and is highly unlikely to cause damage to marine mammal hearing (Todd *et al*., 2015). For example, a study by Reine and Clarke (2014) found that, using a propagation loss coefficient of 15LogR, source levels of dredging operations in the shallow waters (less than 15 m depth) in New York Harbor were measured at and did not exceed 151 dB re 1 μPa, which is not expected to cause hearing shifts in marine mammals. A more recent analysis by McQueen *et al*. (2020) found that, using a maximum sound level of 192 dB re 1 μPa, the resulting isopleths for representative marine mammals (*i.e.*, the harbor seal and harbor porpoise), the resulting isopleths for temporary shifts in hearing would occur less than 20 m and less than 74 m, respectively. Isopleths for permanent shifts occurred at distances of less than 1 m for both marine mammal species.

While NMFS acknowledges the potential for masking or slight behavioral changes to occur during dredging activities (Todd *et al.*, 2015), any effects on marine mammals are expected to be short-term, low intensity, and unlikely to qualify as a take. Given the size of the area in which dredging operations would be occurring, as well as the coastal nature of some of these activities for the nearshore sea-to-shore connection points related to temporary cofferdam installation/removal, NMFS expects that any marine mammals would not be exposed at levels or durations likely to disrupt normal life activities (*i.e.*, migrating, foraging, calving, etc.). Therefore, the potential for take of marine mammals to result from these activities is so low as to be discountable. Revolution Wind did not request, and NMFS does not propose to authorize, any take of marine mammals associated with dredging; dredging activities are not analyzed further in this document.

Boulder Clearance

Boulder clearance may occur prior to and during offshore installation construction activities associated with the RWEC, foundation preparation, and the inter-array cable and OSS-Link cable installation, during which a number of different vessels and equipment types would be utilized. The techniques that may be used to remove or relocate surface or partially embedded boulders and debris, primarily during installation of the RWEC, include using a Boulder Grab or a Boulder Plow. The Boulder Grab would be lowered to the seabed over a targeted boulder, then grab the boulder to relocate it to a site away from the RWEC corridor. Alternatively, boulder clearance could be accomplished using a high-bollard pull vessel with a towed plow generally forming an extended V-shaped configuration, splaying from the rear of the main chassis (*i.e.*, Boulder Plow). The V-shaped configuration displaces any boulders to the extremities of the plow, thus clearing the corridor. Multiple iterations of this process may be required to clear a particular section of the corridor. A tracked plow with a front blade similar to a bulldozer may also be used to push boulders away from the corridor. Based on Revolution Wind's review of site-specific geophysical data, it is assumed that a boulder plow may be used in all areas of higher boulder/debris concentrations, conservatively estimated to be up to 60 percent per cable route of the RWEC and 80 percent of the entire inter-array cable network. Both within these areas of higher boulder and debris concentrations and outside of these areas, a boulder grab may be used to remove larger and/or isolated targets. The size of boulders that can be relocated is dependent on a number of factors including the boulder weight, dimensions, embedment, density and ground conditions. Typically, boulders with dimensions less than 8 ft (2.5 m) can be relocated with standard tools and equipment.

NMFS does not expect boulder clearance to generate noise levels that would cause take of marine mammals. Underwater noise associated with boulder clearance is expected to be similar in nature to the sound produced by the dynamic positioning (DP) cable lay vessels used during cable installation activities within the RWEC. Sound produced by DP vessels is considered non-impulsive and is typically more dominant than mechanical or hydraulic noises produced from the cable trenching or boulder removal vessels and equipment. Therefore, noise produced by the high bollard pull vessel with a towed plow or a support vessel carrying a boulder grab would be comparable to or less than the noise produced by DP vessels, so impacts are also expected to be similar. Boulder clearance is a discrete action occurring over a short duration resulting in short term direct effects. Additionally, sound produced by boulder clearance vessels and equipment would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for startle or flight responses on the part of marine mammals. The Revolution Wind DEIS (BOEM, 2022), issued by BOEM on September 2, 2022, discusses boulder clearance in multiple sections, providing summaries of the boulder clearance methodologies described in Revolution Wind's COP. BOEM has deemed boulder clearance activities as a non-noise generating activity; therefore, the DEIS does not describe boulder clearance activities as a source of noise impacts (BOEM, 2022).

While NMFS acknowledges the potential for slight behavioral changes to occur during boulder clearance, any effects on marine mammals are expected to be short-term, low intensity, and unlikely to qualify as a take. Given that boulder clearance is expected to be extremely localized at any given time, NMFS expects that any marine mammals would not be exposed at levels or durations likely to disrupt normal life activities (*i.e.*, migrating, foraging, calving, etc.). Therefore, the potential for take of marine mammals to result from these activities is so low as to be discountable. Revolution Wind did not request, and NMFS does not propose to authorize, any take associated with boulder clearance; therefore, boulder clearance activities are not analyzed further in this document.

Cable Laying and Installation

Cable burial operations would occur both in RWF for the inter-array cables connecting the 79 WTGs to the two OSSs, and in the RWEC corridor for cables carrying power from the OSSs to shore. A single offshore export cable would connect the OSSs to the sea-to-shore transition point in Quonset Point, Rhode Island. All cable burial operations would follow installation of the monopile foundations, as the foundations must be in place to provide connection points for the export cable and inter-array cables.

All cables would be buried below the seabed, when possible, and buried onshore up to the transition joint bays. The targeted burial depths would be determined later by Revolution Wind, following a detailed design and Cable Burial Risk Assessment. This Assessment would note where burial cannot occur, where sufficient depths cannot be achieved, and/or where additional protection is required due to the export cable crossing other cables or pipelines (either related to the Revolution Wind project or not). Burial of cables would be performed by specific vessels, which are described in Table 3.3.10-3 in the Revolution Wind COP, available at: *https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan*.

Cable laying, cable installation, and cable burial activities planned to occur during the construction of Revolution Wind may include the following:

- Jetting;
- Vertical injection;
- Leveling;
- Mechanical cutting;
- Plowing (with or without jet-assistance);
- Pre-trenching; and,
- Controlled flow excavation.

Some dredging may be required prior to cable laying due to the presence of sandwaves. Sandwave clearance may be undertaken where cable exposure is predicted over the lifetime of the Project due to seabed mobility. This facilitates cable burial below the reference seabed. Alternatively, sandwave clearance may be undertaken where slopes become greater than approximately 10 degrees (17.6 percent), which could cause instability to the burial tool. The work could be undertaken by traditional dredging methods such as a trailing suction hopper. Alternatively, controlled flow excavation or a sandwave removal plough could be used. In some cases, multiple passes may be required. The method of sandwave clearance Revolution Wind chooses would be based on the results from the site investigation surveys and cable design. More information on cable laying associated with the proposed project is provided in Revolution Wind's COP (Revolution Wind, 2022) available at *https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan*.

As the noise levels generated from this activity are low, the potential for take of marine mammals to result is discountable (86 FR 8490; February 5, 2021) and Revolution Wind did not request, and NMFS is not proposing to authorize, marine mammal take associated with cable laying. Therefore, cable laying activities are not analyzed further in this document.

Helicopter Flights

Helicopters may be used during RWF construction and operation phases for crew transfer activities to provide a reduction in the overall transfer time, as well as to reduce the number of vessels on the water. Two of the closest ports to the Revolution Wind lease area are the Port of Davisville at Quonset Point, RI, and New Bedford, MA. Both of these are located approximately 45 km (28 mi) from the nearest portion of the lease area and 70–80 km (44–49 mi) from the most distant parts of the lease area. Assuming a vessel speed of 10 knots, a one-way trip from one of these ports by vessel would require between 2.4 and 4.3 hours. Typical crew transfer helicopters are capable of maximum cruising speeds of approximately 140 knots. Assuming a somewhat slower speed of 120 knots, a one-way trip by helicopter would require 12–22 minutes, thus reducing transit time by 92 percent (Revolution Wind, 2022c).

Without the use of helicopters, all crew transfers to/from offshore locations would be conducted by vessel (either a dedicated crew transfer vessel or other project vessel transiting between a port and the offshore location). Tables 3 and 4 reflect the use of helicopters; therefore, if Revolution Wind did not use helicopters, the amount of crew vessel activity would be higher. Use of helicopters may be limited by many factors, such as logistical constraints (*e.g.*, ability to land on the vessels) and weather conditions that affect flight operations (Revolution Wind, 2022c). Helicopter use also adds significant health, safety and environment (HSE) risk to personnel and, therefore, requires substantially more crew training and additional safety procedures (Revolution Wind, 2022c). These factors can result in significant limitations to helicopter usage. To maintain construction schedules and reliable wind farm operations, the necessity for crew transfers, by vessels or helicopter, would remain a core component of offshore wind farm construction and operations.

Helicopters produce sounds that could be audible to marine mammals. Sound generated by aircraft, both fixed wing and helicopters, is produced in air, but can transmit through the water surface and propagate underwater. In general, underwater sound levels produced by fixed wing aircraft and helicopters are typically low-frequency (16-500 Hz) and range between 84-159 dB re 1 μPa (Richardson *et al*., 1995; Patenaude *et al*., 2002; Erbe *et al*., 2018). However, most sound energy from aircraft reflects off the air-water interface; only sound radiated downward within a 26-degree cone penetrates below the surface water (Urick, 1972). To the extent noise from helicopters transmits from air through the water surface, there is potential to cause temporary changes in behavior and localized displacement of marine mammals (Richardson *et al.*, 1985a; Richardson and Würsig, 1997; Nowacek *et al*., 2007).

Marine mammals tend to react to aircraft noise more often when the aircraft is lower in altitude, closer in lateral distance, and flying over shallow water (Richardson *et *al*., 1985b; Patenaude *et al*., 2002). Temporary reactions by marine mammals may include short surfacing, hasty dives, aversion from the aircraft or dispersal from the incoming aircraft (Bel'kovich, 1960; Kleĭnenberg *et al*., 1964; Richardson *et al*., 1985a; Richardson *et al*., 1985b; Luksenburg and Parsons, 2009). The response of marine mammals to aircraft noise largely depends on the species as well as the animal's behavioral state at the time of exposure (*e.g.*, migrating, resting, foraging, socializing) (Würsig *et al*., 1998). A study conducted in the Beaufort Sea in northern Alaska observed a general lack of reaction in bowhead and beluga whales to passing helicopters (Patenaude *et al*., 2002). Patenaude *et al*. (2002) reported behavioral responses by only 17 percent of the observed bowhead whales to passing helicopters at altitudes below 150 m and within a lateral distance of 250 m. Similarly, most observed beluga whales did not show any visible reaction to helicopters passing when flight altitudes were over 150 m (Patenaude *et al*., 2002). Although the sound emitted by aircraft has the potential to result in temporary behavioral responses in marine mammals, project-related aircraft would only occur at low altitudes over water during takeoff and landing at an offshore location where one or more vessels are located. Due to the intermittent nature of helicopter flights, the higher altitude, and the small area potentially ensonified by this sound source, both Revolution Wind and NMFS expect the potential for take of marine mammals incidental to helicopter use to be discountable. The use of helicopters to conduct crew transfers is likely to provide an overall benefit to marine mammals in the form of reduced vessel activity. Revolution Wind did not request, and NMFS is not proposing to authorize, take of marine mammals incidental to Revolution Wind's use of helicopters. This activity is not discussed or analyzed further herein.

Description of Marine Mammals in the Area of Specified Activities

Forty marine mammal species and/or stocks have geographic ranges within the western North Atlantic OCS (Table 5 in Revolution Wind ITA application). However, for reasons described below, Revolution Wind has requested, and NMFS proposes to authorize, take of only 16 species (comprising 16 stocks). Sections 3 and 4 of Revolution Wind's application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. NMFS fully considered all of this information, and we refer the reader to these descriptions in the application, incorporated here by reference, instead of reprinting the information. Additional information regarding population trends and threats may be found in NMFS's Stock Assessment Reports (SARs; *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*) and more general information about these species (*e.g.*, physical and behavioral descriptions) may be found on NMFS's website (*https://www.fisheries.noaa.gov/find-species*).

Table 5 lists all species and stocks for which take is expected and proposed to be authorized for this action, and summarizes information related to the population or stock, including regulatory status under the MMPA and Endangered Species Act (ESA) and potential biological removal (PBR), where known. PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population as described in 16 U.S.C. 1362(20) and as described in NMFS' SARs. While no mortality is anticipated or authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic and Gulf of Mexico SARs. All values presented in Table 5 are the most recent available at the time of publication and are available in NMFS' 2021 SARs (Hayes *et al*., 2022), available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/draft-marine-mammal-stock-assessment-reports*.

Table 5. Marine Mammal Species Likely to Occur near the Project Area That May be Taken by Revolution Wind's Activities

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N)[1]	Stock abundance (CV, N_{min}, most recent abundance survey)[2]	PBR	Annual M/SI[3]
Order Artiodactyla – Cetacea – Superfamily Mysticeti (baleen whales)						
Family Balaenidae						
North Atlantic right whale	*Eubalaena glacialis*	Western Atlantic	E, D, Y	368 (0; 364; 2019) [5]	0.7	7.7
Family Balaenopteridae (rorquals)						
Blue whale	*Balaenoptera musculus*	Western North Atlantic	E, D, Y	UNK (UNK; 402; 1980-2008)	0.8	0
Fin whale	*Balaenoptera physalus*	Western North Atlantic	E, D, Y	6,802 (0.24; 5,573; 2016)	11	1.8
Sei whale	*Balaenoptera borealis*	Nova Scotia	E, D, Y	6,292 (1.02; 3,098; 2016)	6.2	0.8
Minke whale	*Balaenoptera acutorostrata*	Canadian Eastern Coastal	-, -, N	21,968 (0.31; 17,002; 2016)	170	10.6
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	-, -, Y	1,396 (0; 1,380; 2016)	22	12.15
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae						
Sperm whale	*Physeter macrocephalus*	North Atlantic	E, D, Y	4,349 (0.28; 3,451; 2016)	3.9	0
Family Delphinidae						
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	-, -, N	93,233 (0.71; 54,433; 2016)	544	27
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	-, -, N	39,921 (0.27; 32,032; 2016)	320	0

Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore	-, -, N	62,851 (0.23; 51,914; 2016)	519	28
Long-finned pilot whales	*Globicephala melas*	Western North Atlantic	-, -, N	39,215 (0.3; 30,627; 2016)	306	29
Risso's dolphin	*Grampus griseus*	Western North Atlantic	-, -, N	35,215 (0.19; 30,051; 2016)	301	34
Common dolphin (short-beaked)	*Delphinus delphis*	Western North Atlantic	-, -, N	172,897 (0.21; 145,216; 2016)	1,452	390
Family Phocoenidae (porpoises)						
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	-, -, N	95,543 (0.31; 74,034; 2016)	851	16
Order Carnivora – Superfamily Pinnipedia						
Family Phocidae (earless seals)						
Gray seal[4]	*Halichoerus grypus*	Western North Atlantic	-, -, N	27,300 (0.22; 22,785; 2016)	1,389	4,453
Harbor seal	*Phoca vitulina*	Western North Atlantic	-, -, N	61,336 (0.08; 57,637; 2018)	1,729	339

1 - ESA status: Endangered (E), Threatened (T) / MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.
2 - NMFS marine mammal stock assessment reports online at: www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments (Hayes et al., 2022). CV is the coefficient of variation; Nmin is the minimum estimate of stock abundance. In some cases, CV is not applicable.
3 - These values, found in NMFS' SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (e.g., commercial fisheries, ship strike).
4 - NMFS' stock abundance estimate (and associated PBR value) applies to the U.S. population only. Total stock abundance (including animals in Canada) is approximately 451,431. The annual M/SI value given is for the total stock.
5 - The draft 2022 SARs have yet to be released; however, NMFS has updated its species web page to recognize the population estimate for right whales is now below 350 animals (https://www.fisheries.noaa.gov/species/north-atlantic-right-whale).
6 - Information on the classification of marine mammal species can be found on the web page for the Society for Marine Mammalogy's Committee on Taxonomy (https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies/; Committee on Taxonomy (2022)).

Of the 40 marine mammal species and/or stocks with geographic ranges that include the western North Atlantic OCS (Table 5 in Revolution Wind ITA application), 24 are not expected to be present or are considered rare or unexpected in the project area based on sighting and distribution data; they are, therefore, not discussed further beyond the explanation provided here. The following species are not expected to occur in the project area due to the location of preferred habitat outside the RWF and RWEC corridor, based on the best available information: dwarf and pygmy sperm whales (*Kogia sima and K breviceps*), northern bottlenose whale (*hyperoodon ampullatus*), cuvier's beaked whale (*Ziphius cavirostris*), four species of Mesoplodont beaked whales (*Mesoplodon densirostris, M. europaeus, M. mirus, and M. bidens*), killer whale (*Orcinus orca*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuata*), short-finned pilot whale (*Globicephala Macrohynchus*), melon-headed whale (*Peponocephala electra*), Fraser's dolphin (*Lagenodelphis hosei*), white-beaked dolphin (*Lagenorhynchus albirostris*), pantropical spotted dolphin (*Stenella attenuata*), Clymene dolphin (*Stenella Clymene*), striped dolphin (*Stenella coeruleoalba*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), and the coastal migratory stock of common bottlenose dolphins (*Tursiops truncatus truncatus*). The following species may occur in the project area, but at such low densities that take is not anticipated: hooded seal (*Cystophora cristata*) and harp seal (*Pagophilus groenlandica*). There are two pilot whale species, long-finned (*Globicephala melas*) and short-finned (*Globicephala macrorhynchus*), with distributions that overlap in the latitudinal range of the RWF (Hayes *et al*., 2020; Roberts *et al*., 2016). Because it is difficult to differentiate between the two species at sea, sightings, and thus the densities calculated from them, are generally reported together as *Globicephala* spp. (Roberts *et al*., 2016; Hayes *et al*., 2020). However, based on the best available information, short-finned pilot whales occur in habitat that is both further offshore on the shelf break and further south than the project area (Hayes *et al*., 2020). Therefore, NMFS assumes that any take of pilot whales would be of long-finned pilot whales.

In addition, the Florida manatee (*Trichechus manatus*; a sub-species of the West Indian manatee) has been previously documented as an occasional visitor to the Northeast region during summer months (U.S. Fish and Wildlife Service (USFWS), 2022). However, manatees are managed by the USFWS and are not considered further in this document. More information on this species can be found at the following website: *https://www.fws.gov/species/manatee-trichechus-manatus*.

Between October 2011 and June 2015, a total of 76 aerial surveys were conducted throughout the MA and RI/MA Wind Energy Areas (WEAs) (the RWF is contained within the RI/MA WEA along with several other offshore renewable energy lease areas). Between November 2011 and March 2015, Marine Autonomous Recording Units (MARU; a type of static passive acoustic monitoring (PAM) recorder) were deployed at nine sites in the MA and RI/MA WEAs. The goal of the study was to collect visual and acoustic baseline data on distribution, abundance, and temporal occurrence patterns of marine mammals (Kraus *et al*., 2016). The lack of detections of any of the 24 species listed above reinforces the fact that they are not expected to occur in the project area. In addition, none of these species were observed during HRG surveys conducted by Ørsted from 2018 to 2021. As these species are not expected to occur in the project area during the proposed activities (based on acoustic detection and PSO data), NMFS does not propose to authorize take of these species and they are not discussed further in this document.

As indicated above, all 16 species and stocks in Table 5 temporally and spatially co-occur with the activity to the degree that taking is reasonably likely to occur. Five of the marine mammal species for which take is requested have been designated as ESA-listed, including North Atlantic right, blue, fin, sei, and sperm whales. In addition to what is included in Sections 3 and 4 of Revolution Wind's ITA application (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-*

construction-revolution-wind-energy), the SARs (*https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*), and NMFS' website (*https://www.fisheries.noaa.gov/species-directory/marine-mammals*), we provide further detail below informing the baseline for select species (*e.g.*, information regarding current Unusual Mortality Events (UME) and known important habitat areas, such as Biologically Important Areas (BIAs) (Van Parijs *et al*., 2015)). There is no ESA-designated critical habitat for any species within the project area.

Under the MMPA, a UME is defined as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response" (16 U.S.C. 1421h(6)). As of December 2022, seven UMEs in total are considered active, with five of these occurring along the U.S. Atlantic coast for various marine mammal species; of these, the most relevant to the Revolution Wind project are the minke, right, and humpback whale, and phocid seal UMEs, given the prevalence of these species in the project area. More information on UMEs, including all active, closed, or pending, can be found on NMFS' website at *https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events.*

Below we include information for a subset of the species that presently have an active or recently closed UMEs occurring along the Atlantic coast, or for which there is information available related to areas of biological significance. For the majority of species potentially present in the specific geographic region, NMFS has designated only a single generic stock (*e.g.*, "western North Atlantic") for management purposes. This includes the "Canadian east coast" stock of minke whales, which includes all minke whales found in U.S. waters and is a generic stock for management purposes. For humpback and sei whales, NMFS defines stocks on the basis of feeding locations, *i.e.*, Gulf of Maine and Nova Scotia, respectively. However, references to humpback whales and sei whales in this document refer to any individuals of the species that are found in the specific geographic region. Any areas of known biological importance (including the Biologically Important Areas (BIAs) identified in Van Parijs *et al*., 2015 and LaBrecque *et al*., 2015) that overlap spatially with the project area are addressed in the species sections below.

North Atlantic Right Whale

The North Atlantic right whale has been listed as an Endangered since 1970. They were recently uplisted from Endangered to Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Cooke, 2020). The uplisting was due to a decrease in population size (Pace *et al*., 2017), an increase in vessel strikes and entanglements in fixed fishing gear (Daoust *et al*., 2017; Davies & Brillant, 2019; Knowlton *et al*., 2012; Sharp *et al*., 2019), and a decrease in birth rate (Pettis *et al*., 2021). The Western Atlantic stock is considered depleted under the MMPA (Hayes *et al.,* 2021). There is a recovery plan (NOAA Fisheries 2017) for the North Atlantic right whale, and NMFS completed a 5-year review of the species in 2017 (NOAA Fisheries 2017). In February 2022, NMFS initiated a 5-year review process (*https://www.fisheries.noaa.gov/action/initiation-5-year-review-north-atlantic-right-whale*).

The right whale population had only a 2.8 percent recovery rate between 1990 and 2011 (Hayes *et al.,* 2022). Since 2010, the North Atlantic right whale population has been in decline (Pace *et al.,* 2017), with a 40 percent decrease in calving rate (Kraus *et al.,* 2016). In 2018, no new right whale calves were documented; this represented the first time since annual NOAA aerial surveys began in 1989 that no new right whale calves were observed within a calving season. Presently, the best available peer-reviewed population estimate for North Atlantic right whales is 368 per the 2021 SARs (Hayes *et* *al*., 2021) (*https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*). The draft 2022 SARs have yet to be released; however, NMFS has updated its species web page to acknowledge that the right whale population estimate is now below 350 animals (*https://www.fisheries.noaa.gov/species/north-atlantic-right-whale*). We note that this change in abundance estimate would not change the estimated take of right whales or the take NMFS has proposed to authorize as take estimates are based on the habitat density models (Roberts *et al*., 2016; Roberts and Halpin, 2022).

Right whale presence in the project area is predominately seasonal; however, year-round occurrence is documented (O'Brien *et al*., 2022, Quintano-Rizzo *et al*., 2021). As a result of recent years of aerial surveys and PAM deployments within the RI/MA WEA, we have confidence that right whales are expected in the project area, in higher numbers in winter and spring followed by decreasing abundance into summer and early fall. The project area both spatially and temporally overlaps a portion of the migratory corridor BIA and migratory route Seasonal Management Area (SMA), within which right whales migrate south to calving grounds generally in November and December, followed by a northward migration into feeding areas east and north of the project area in March and April (LaBrecque *et al*., 2015; Van Parijs *et al*., 2015). While the project does not overlap previously identified critical feeding habitat or a feeding BIA, it is located just west of a more recently described important feeding area south of Martha's Vineyard and Nantucket, along the western side of Nantucket Shoals. Finally, the project overlaps the Block Island SMA, which may be used by right whales for various activities, including feeding and migration. Due to the current status of North Atlantic right whales, and the overlap of the proposed project with areas of biological significance (*i.e.*, a migratory corridor, SMA), the potential impacts of the proposed project on right whales warrant particular attention.

Elevated right whale mortalities have occurred since June 7, 2017, along the U.S. and Canadian coast, with the leading category for the cause of death for this UME determined to be "human interaction," specifically from entanglements or vessel strikes. As of November 2022, there have been 34 confirmed mortalities (dead stranded or floaters; 21 in Canada; 13 in the United States) and 21 seriously injured free-swimming whales for a total of 55 whales. As of November 15, 2022, the UME also considers animals with sublethal injury or illness bringing the total number of whales in the UME to 92. Approximately 42 percent of the population is known to be in reduced health (Hamilton *et al.,* 2021), likely contributing to the smaller body sizes at maturation (Stewart *et al.,* 2022) and making them more susceptible to threats. More information about the Norrth Atlantic right whale UME is available online at: *www.fisheries.noaa.gov/national/marine-life-distress/2017-2021-north-atlantic-right-whale-unusual-mortality-event.*

North Atlantic right whales may be present in New England waters year-round; however, their presence is limited during summer months. These waters are both a migratory corridor in the spring and early winter and a primary feeding habitat for right whales during late winter through spring. Habitat-use patterns within the region have shifted in relatively recent years (Davis *et al*., 2020; Quintano-Rizzo *et al*., 2021; O'Brien *et al*., 2022). Since 2010, right whales have reduced their use of foraging habitats in the Great South Channel and Bay of Fundy, while increasing their use of habitat within Cape Cod Bay, as well as a region south of Martha's Vineyard and Nantucket Islands, just to the east of the RWF and RWEC corridor (Stone *et al.,* 2017; Mayo *et al.,* 2018; Ganley *et al.,* 2019; Record *et al.,* 2019; Meyer-Gutbrod *et al.,* 2021). Pendleton *et al.* (2022) found that peak use of right whale foraging habitat in Cape Cod Bay has shifted over the past 20 years to later in the spring, likely due to variations in seasonal conditions. Right whales have recently been observed feeding year-round in the region south of Martha's Vineyard and Nantucket with larger numbers in this area in the winter, making it the only known winter foraging habitat for the species (Quintana-Rizzo *et al*., 2021). Right whale use of habitats such as in the Gulf of St. Lawrence and East Coast mid-Atlantic waters of the have also increased over time (Davis *et al.,* 2017; Davis and Brillant, 2019; Crowe *et al.,* 2021; Quintana-Rizzo *et al.,* 2021). Simard *et al.* (2019) documented the presence of right whales in the southern Gulf of St. Lawrence foraging habitat from late April through mid-January annually from 2010-2018 using passive acoustics, with occurrences peaking in the area from August through November each year (Simard *et al.,* 2019). These shifts in foraging habitat use are likely due to changes in oceanographic conditions and food supply as dense patches of zooplankton are necessary for efficient foraging (Mayo and Marx, 1990; Record *et al.,* 2019). Observations of these transitions in right whale habitat use, variability in seasonal presence in identified core habitats, and utilization of habitat outside of previously focused survey effort prompted the formation of a NMFS' Expert Working Group, which identified current data collection efforts, data gaps, and provided recommendations for future survey and research efforts (Oleson *et al*., 2020).

In late fall (*i.e.,* November), a portion of the right whale population (including pregnant females) typically departs the feeding grounds in the North Atlantic, moves south along the migratory corridor BIA, including through the project area, to right whale calving grounds off Georgia and Florida. However, recent research indicates understanding of their movement patterns remains incomplete and not all of the population undergoes a consistent annual migration (*e.g.*, Davis *et al.,* 2017; Quintana-Rizzo *et al,* 2021). The results of multistate temporary emigration capture-recapture modeling, based on sighting data collected over the past 22 years, indicate that non-calving females may remain in the feeding grounds, during the winter in the years preceding and following the birth of a calf to increase their energy stores (Gowen *et al*., 2019).

Within the project area, right whales have primarily been observed during the winter and spring seasons through recent visual surveys (Kraus *et al.,* 2016; Quintana-Rizzo *et al.,* 2021). During aerial surveys conducted in the RI/MA and MA WEAs from 2011-2015, the highest number of right whale sightings occurred in March (n=21), with sightings also occurring in December (n=4), January (n=7), February (n=14), and April (n=14), and no sightings in any other months (Kraus *et al*., 2016). There was not significant variability in sighting rate among years, indicating consistent annual seasonal use of the area by right whales. Despite the lack of visual detection, right whales were acoustically detected in 30 out of the 36 recorded months (Kraus *et al*., 2016). Since 2017, right whales have been sighted in the southern New England area nearly every month, with peak sighting rates between late winter and spring. Model outputs suggest that 23 percent of the right population is present from December through May, and the mean residence time has tripled to an average of 13 days during these months (Quintano-Rizzo *et al*., 2021). A hotspot analysis analyzing sighting data in southern New England from 2011-2019 indicated that right whale occurrence in the Revolution Wind project area was highest in the spring (March through May), and that few right whales were sighted in the area during that time frame in summer or winter (Quintano-Rizzo *et al*., 2021), a time when right whales distribution shifted to the east and south into other portions of the study area.

North Atlantic right whale distribution can also be derived from acoustic data. A review of passive acoustic monitoring data from 2004 to 2014 collected throughout the western North Atlantic demonstrated nearly continuous year-round right whale presence across their entire habitat range, including in locations previously thought of as migratory corridors, suggesting that not all of the population undergoes a consistent annual migration (Davis *et al.,* 2017). Acoustic monitoring data from 2004 to 2014 indicated that the number of right whale vocalizations detected in southern New England were relatively constant throughout the year, with the exception of August through October when detected vocalizations showed an apparent decline (Davis *et al.,* 2017).

While density data from Roberts *et al*. (2022) confirm that the highest average density of right whales in the project area (both the lease area and RWEC corridor) occurs in March (0.0060 whales/100km^2), which aligns with available sighting and acoustic data, it is clear that that habitat use is changing and right whales are present to some degree in or near the project area throughout the year, most notably south of Martha's Vineyard and Nantucket Islands (Leiter *et al*., 2017; Stone *et al*., 2017; Oleson *et al*., 2020, Quintano-Rizzo *et al*., 2021). Since 2010, right whale abundances have increased in Southern New England waters, south of Martha's Vineyard and Nantucket Islands. O'Brien *et al*. (2022) detected significant increases in right whale abundance during winter and spring seasons from 2013-2019, likely due to changes in prey availability. Since 2017, right whales were also detected in small numbers during summer and fall, suggesting that these waters provide year-round habitat for right whales (O'Brien *et al*., 2022).

NMFS' regulations at 50 CFR 224.105 designated nearshore waters of the Mid-Atlantic Bight as Mid-Atlantic U.S. Seasonal Management Areas for right whales in 2008. SMAs were developed to reduce the threat of collisions between ships and right whales around their migratory route and calving grounds. As mentioned previously, the Block Island SMA overlaps spatially with the proposed project area (*https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html*). The SMA is currently active from November 1 through April 30 of each year and may be used by right whales for feeding (although to a lesser extent than the area to the east near Nantucket Shoals) and/or migrating.

Humpback Whale

Humpback whales are a cosmopolitan species found worldwide in all oceans, but were listed as endangered under the Endangered Species Conservation Act (ESCA) in June 1970. In 1973, the ESA replaced the ESCA, and humpbacks continued to be listed as endangered.

On September 8, 2016, NMFS divided the once single species into 14 distinct population segments (DPS), removed the species-level listing, and, in its place, listed four DPSs as endangered and one DPS as threatened (81 FR 62259; September 8, 2016). The remaining nine DPSs were not listed. The West Indies DPS, which is not listed under the ESA, is the only DPS of humpback whales that is expected to occur in the project area. Bettridge *et al.* (2015) estimated the size of the West Indies DPS population at 12,312 (95 percent CI 8,688-15,954) whales in 2004-05, which is consistent with previous population estimates of approximately 10,000-11,000 whales (Stevick *et al.,* 2003; Smith *et al.,* 1999) and the increasing trend for the West Indies DPS (Bettridge *et al.,* 2015).

In New England waters, feeding is the principal activity of humpback whales, and their distribution in this region has been largely correlated to abundance of prey species (Payne *et al.,* 1986, 1990). Humpback whales are frequently piscivorous when in New England waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes spp.*), and other small fishes, as well as euphausiids in the northern Gulf of Maine (Paquet *et al.,* 1997). Kraus *et al.* (2016) observed humpbacks in the RI/MA & MA Wind Energy Areas (WEAs) and surrounding areas during all seasons, but most often during spring and summer months, with a peak from April to June. Acoustic data indicate that this species may be present within the RI/MA WEA year-round, with the highest rates of acoustic detections in the winter and spring (Kraus *et al.,* 2016).

A humpback whale feeding BIA extends throughout the Gulf of Maine, Stellwagen Bank, and Great South Channel from May through December, annually

(LeBrecque *et al.*, 2015). However, this BIA is located further east and north of, and thus does not overlap, the project area. The project area does not overlap any critical habitat for the species.

Since January 2016, elevated humpback whale mortalities along the Atlantic coast from Maine to Florida led to the declaration of a UME. Partial or full necropsy examinations have been conducted on approximately half of the 168 known cases (as of December 6, 2022). Of the whales examined, about 50 percent had evidence of human interaction, either ship strike or entanglement. While a portion of the whales have shown evidence of pre-mortem vessel strike, this finding is not consistent across all whales examined and more research is needed. NOAA is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. More information is available at: *www.fisheries.noaa.gov/national/marine-life-distress/2016-2021-humpback-whale-unusual-mortality-event-along-atlantic-coast.*

Fin whale

Fin whales typically feed in the Gulf of Maine and the waters surrounding New England, but their mating and calving (and general wintering) areas are largely unknown (Hain *et al*., 1992; Hayes *et al*., 2018). Recordings from Massachusetts Bay, New York Bight, and deep-ocean areas have detected some level of fin whale singing from September through June (Watkins *et al*., 1987; Clark and Gagnon, 2002; Morano *et al*., 2012). These acoustic observations from both coastal and deep-ocean regions support the conclusion that male fin whales are broadly distributed throughout the western North Atlantic for most of the year (Hayes *et al*., 2019).

Kraus *et al*. (2016) suggest that, compared to other baleen whale species, fin whales have a high multi-seasonal relative abundance in the RI/MA & MA WEAs and surrounding areas. Fin whales were observed in the MA WEA in spring and summer. This species was observed primarily in the offshore (southern) regions of the RI/MA & MA WEAs during spring and was found closer to shore (northern areas) during the summer months (Kraus *et al*., 2016). Calves were observed three times and feeding was observed nine times during the Kraus *et al*. (2016) study. Although fin whales were largely absent from visual surveys in the RI/MA and MA WEAs in the fall and winter months (Kraus *et al*. 2016), acoustic data indicated that this species was present in these areas during all months of the year.

New England waters represent a major feeding ground for fin whales. The proposed project area would overlap spatially and temporally with approximately 11 percent of a relatively small fin whale feeding BIA (2,933 km^2) offshore of Montauk Point, from March to October (Hain *et al.,* 1992; LaBrecque *et al*., 2015). A separate larger year-round feeding BIA (18,015 km^2) to the east in the southern Gulf of Maine does not overlap with the project area, and would thus not be impacted by project activities.

Minke Whale

Minke whale occurrence is common and widespread in New England from spring to fall, although the species is largely absent in the winter (Hayes *et al.,* 2021; Risch *et al.,* 2013). Surveys conducted in the RI/MA WEA from October 2011 through June 2015 reported 103 minke whale sightings within the area, predominantly in the spring, followed by summer and fall (Kraus *et al.,* 2016).

There are two minke whale feeding BIAs in the southern and southwestern section of the Gulf of Maine, including Georges Bank, the Great South Channel, Cape Cod Bay, Massachusetts Bay, Stellwagen Bank, Cape Anne, and Jeffreys Ledge from March through November, annually (LeBrecque *et al.*, 2015). However, these BIAs do not overlap the project area, as they are located further east and north. The proposed project area likely serves as a migratory route for minke whales transiting between northern feeding grounds and southern breeding areas.

Since January 2017, elevated minke whale mortalities detected along the Atlantic coast from Maine through South Carolina resulted in the declaration of a UME. As of December 6, 2022, a total of 135 minke whales have stranded during this UME. Full or partial necropsy examinations were conducted on more than 60 percent of the whales. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease, but these findings are not consistent across all of the whales examined, so more research is needed. More information is available at: *www.fisheries.noaa.gov/national/marine-life-distress/2017-2021-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Seals

Since June 2022, elevated numbers of harbor seal and gray seal mortalities have occurred across the southern and central coast of Maine. This event has been declared a UME. Preliminary testing of samples has found some harbor and gray seals positive for highly pathogenic avian influenza. While the UME is not occurring in the Revolution Wind project area, the populations affected by the UME are the same as those potentially affected by the project.

The above event was preceded by a different UME, occurring from 2018-2020 (closure of the 2018-2020 UME is pending). Beginning in July 2018, elevated numbers of harbor seal and gray seal mortalities occurred across Maine, New Hampshire and Massachusetts. Additionally, stranded seals have shown clinical signs as far south as Virginia, although not in elevated numbers, therefore the UME investigation encompassed all seal strandings from Maine to Virginia. A total of 3,152 reported strandings (of all species) occurred from July 1, 2018, through March 13, 2020. Full or partial necropsy examinations have been conducted on some of the seals and samples have been collected for testing. Based on tests conducted thus far, the main pathogen found in the seals is phocine distemper virus. NMFS is performing additional testing to identify any other factors that may be involved in this UME, which is pending closure. Information on this UME is available online at: *www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/2018-2020-pinniped-unusual-mortality-event-along.*

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.*, Richardson *et al.*, 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.*, low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 6.

Table 6. Marine Mammal Hearing Groups (NMFS, 2018)

Hearing Group	Generalized Hearing Range*
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall *et al.,* 2007) and PW pinniped (approximation).	

The pinniped functional hearing group was modified from Southall *et al*. (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al*., 2006; Kastelein *et al*., 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information. Sixteen marine mammal species (14 cetacean species (6 mysticetes and 8 odontocetes) and 2 pinniped species (both phocid seals)) have the reasonable potential to co-occur with the proposed project activities (Table 5).

NMFS notes that in 2019, Southall *et al*. recommended new names for hearing groups that are widely recognized. However, this new hearing group classification does not change the weighting functions or acoustic thresholds (*i.e.*, the weighting functions and thresholds in Southall *et al*. (2019) are identical to NMFS 2018 Revised Technical Guidance). When NMFS updates our Technical Guidance, we will be adopting the updated Southall *et al*. (2019) hearing group classification.

Potential Effects to Marine Mammals and their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The **Estimated**

Take section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The **Negligible Impact Analysis and Determination** section considers the content of this section, the **Estimated Take** section, and the **Proposed Mitigation** section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and how those impacts on individuals are likely to impact marine mammal species or stocks. General background information on marine mammal hearing was provided previously (see the **Description of Marine Mammals in the Area of the Specified Activities** section). Here, the potential effects of sound on marine mammals are discussed.

Revolution Wind has requested authorization to take marine mammals incidental to construction activities in the Revolution Wind project area. In the ITA application, Revolution Wind presented analyses of potential impacts to marine mammals from use of acoustic and explosive sources. NMFS both carefully reviewed the information provided by Revolution Wind, as well as independently reviewed applicable scientific research and literature and other information, to evaluate the potential effects of Revolution Wind's activities on marine mammals, which are presented in this section.

The proposed activities would result in placement of up to 81 permanent foundations and two temporary cofferdams in the marine environment. Up to 13 UXO/MEC detonations may occur intermittently, only as necessary. There are a variety of effects to marine mammals, prey species, and habitat that could occur as a result of these actions.

Description of Sound Sources

This section contains a brief technical background on sound, on the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document. For general information on sound and its interaction with the marine environment, please see, *e.g.*, Au and Hastings (2008), Richardson *et al*. (1995), and Urick (1983).

Sound is a vibration that travels as an acoustic wave through a medium such as a gas, liquid or solid. Sound waves alternately compress and decompress the medium as the wave travels. These compressions and decompressions are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones (underwater microphones). In water, sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam (narrow beam or directional sources) or sound beams may radiate in all directions (omnidirectional sources).

Sound travels in water more efficiently than almost any other form of energy, making the use of acoustics ideal for the aquatic environment and its inhabitants. In seawater, sound travels at roughly 1,500 meters per second (m/s). In -air, sound waves travel much more slowly, at about 340 m/s. However, the speed of sound can vary by a small amount based on characteristics of the transmission medium, such as water temperature and salinity.

The basic components of a sound wave are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in Hz or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. The intensity (or amplitude) of sounds are measured in decibels (dB), which are a relative unit of measurement that is used to express the ratio of one value of a power or field to another. Decibels are measured on a logarithmic scale, so a small change in dB corresponds to large changes in sound pressure. For example, a 10-dB increase is a ten-fold increase in acoustic power. A 20-dB increase is then a 100-fold increase in power and a 30-dB increase is a 1000-fold increase in power. However, a ten-fold increase in acoustic power does not mean that the sound is perceived as being ten times louder. Decibels are a relative unit comparing two pressures, therefore a reference pressure must always be indicated. For underwater sound, this is 1 microPascal (μPa). For in-air sound, the reference pressure is 20 microPascal (μPa). The amplitude of a sound can be presented in various ways; however, NMFS typically utilizes three metrics.

Sound exposure level (SEL) represents the total energy in a stated frequency band over a stated time interval or event, and considers both amplitude and duration of exposure (represented as dB re 1 μPa^2-s). SEL is a cumulative metric; it can be accumulated over a single pulse (for pile driving this is often referred to as single-strike SEL; SEL_{ss}), or calculated over periods containing multiple pulses (SEL_{cum}). Cumulative SEL represents the total energy accumulated by a receiver over a defined time window or during an event. The SEL metric is useful because it allows sound exposures of different durations to be related to one another in terms of total acoustic energy. The duration of a sound event and the number of pulses, however, should be specified as there is no accepted standard duration over which the summation of energy is measured.
Sounds are typically classified by their spectral and temporal properties.

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Root mean square is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). Root mean square accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure. Along with SEL, this metric is used in evaluating the potential for permanent threshold shift (PTS) and temporary threshold shift (TTS). It is also used to evaluate the potential for gastro-intestinal tract injury (Level A harassment) from explosives.

For explosives, an impulse metric (Pa-s), which is the integral of a transient sound pressure over the duration of the pulse, is used to evaluate the potential for mortality (*i.e.,* severe lung injury) and slight lung injury. These thresholds account for animal mass and depth.

Sounds can be either impulsive or non-impulsive. The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.*, Ward, 1997 in Southall *et al.*, 2007). Please see NMFS *et al*. (2018) and Southall *et al*. (2007, 2019) for an in-depth discussion of these concepts. Impulsive sound sources (*e.g.*, airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (American National Standards Institute (ANSI), 1986, 2005; Harris, 1998; National Institute for Occupational Safety and Health (NIOSH), 1998; International Organization for Standardization (ISO), 2003) and occur either as isolated events or repeated in some succession. Impulsive sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features. Impulsive sounds are typically intermittent in nature.

Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI, 1995; NIOSH, 1998). Some of these non-impulsive sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.*, rapid rise time). Examples of non-impulsive sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems.

Sounds are also characterized by their temporal component. Continuous sounds are those whose sound pressure level remains above that of the ambient sound, with negligibly small fluctuations in level (NIOSH, 1998; ANSI, 2005), while intermittent sounds are defined as sounds with interrupted levels of low or no sound (NIOSH, 1998). NMFS identifies Level B harassment thresholds based on if a sound is continuous or intermittent.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound, which is defined as environmental background sound levels lacking a single source or point (Richardson *et al*., 1995). The sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.*, wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.*, sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.*, vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including wind and waves, which are a main source of naturally occurring ambient sound for frequencies between 200 Hz and 50 kHz (International Council for Exploration of the Sea (ICES), 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Precipitation can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times. Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz. Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, and explosions. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly.

The sum of the various natural and anthropogenic sound sources that comprise ambient sound at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10-20 dB from day to day (Richardson *et al*., 1995). The result is that, depending on the source type and its intensity, sound from the specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Underwater ambient sound in the Atlantic Ocean southeast of Rhode Island comprises sounds produced by a number of natural and anthropogenic sources. Human-generated sound is a significant contributor to the acoustic environment in the project location.

Potential Effects of Underwater Sound on Marine Mammals

Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. Broadly, underwater sound from active acoustic sources can potentially result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al*., 1995; Gordon *et al*., 2003; Nowacek *et al*., 2007; Southall *et al*., 2007; Götz *et al*., 2009). Potential effects from explosive sound sources can range in severity from behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al*., 1973). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure, in addition to the contextual factors of the receiver (*e.g.*, behavioral state at time of exposure, age class, etc.). In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We describe below the specific manifestations of acoustic effects that may occur based on the activities proposed by Revolution Wind.

Richardson *et al*. (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First (at the greatest distance) is the area within which the acoustic signal would be audible (potentially perceived) to the animal but not strong enough to elicit any overt behavioral or physiological response. The next zone (closer to the receiving animal) corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. The third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.*, when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

Potential effects from explosive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al*., 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.*, change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al*., 2006; Southall *et al*., 2007; Zimmer and Tyack, 2007; Tal *et al*., 2015).

Below, we provide additional detail regarding potential impacts on marine mammals and their habitat from noise in general, as well as from the specific activities Revolution Wind plans to conduct, to the degree it is available (noting that there is limited information regarding the impacts of offshore wind construction on cetaceans).

Threshold Shift

Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift (TS), which NMFS defines as a change, usually an increase, in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level, expressed in decibels (NMFS, 2018). Threshold shifts can be permanent, in which case there is an irreversible increase in the threshold of audibility at a specified frequency or portion of an individual’s hearing range, or temporary, in which there is reversible increase in the threshold of audibility at a specified frequency or portion of an individual’s hearing range and the animal's hearing threshold would fully recover over time (Southall *et al*., 2019). Repeated sound exposure that leads to TTS could cause PTS.

When PTS occurs, there can be physical damage to the sound receptors in the ear (*i.e.*, tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Henderson *et al.,* 2008). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.*, Ward, 1997; Southall *et al.,* 2019). Therefore, NMFS does not consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several decibels above (a 40 dB threshold shift approximates a PTS onset; *e.g.*, Kryter *et al*., 1966; Miller, 1974; Henderson *et al*., 2008). This can also induce mild TTS (a 6 dB threshold shift approximates a TTS onset; *e.g.,* Southall *et al*., 2019). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds, expressed in the unweighted peak sound pressure level metric (PK), for impulsive sounds (such as impact pile driving pulses) are at least 6 dB higher than the TTS thresholds and the weighted PTS cumulative sound exposure level thresholds are 15 (impulsive sound) to 20 (non-impulsive sounds) dB higher than TTS cumulative sound exposure level thresholds (Southall *et al*., 2019). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, PTS is less likely to occur as a result of these activities, but it is possible and a small amount has been proposed for authorization for several species.

TTS is the mildest form of hearing impairment that can occur during exposure to sound, with a TTS of 6 dB considered the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject’s normal hearing ability (Schlundt *et al*., 2000; Finneran *et al*., 2000; Finneran *et al*., 2002).

While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. There is data on sound levels and durations necessary to elicit mild TTS for marine mammals but recovery is complicated to predict and dependent on multiple factors.

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.*, recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale (*Delphinapterus leucas*), harbor porpoise, and Yangtze finless porpoise (*Neophocoena asiaeorientalis*)) and six species of pinnipeds (northern elephant seal (*Mirounga angustirostris*), harbor seal, ring seal, spotted seal, bearded seal, and California sea lion (*Zalophus californianus*)) that were exposed to a limited number of sound sources (*i.e.*, mostly tones and octave-band noise with limited number of exposure to impulsive sources such as seismic airguns or impact pile driving) in laboratory settings (Southall *et al*., 2019). There is currently no data available on noise-induced hearing loss for mysticetes. For summaries of data on TTS or PTS in marine mammals or for further discussion of TTS or PTS onset thresholds, please see Southall *et al*. (2019), and NMFS (2018).

Recent studies with captive odontocete species (bottlenose dolphin, harbor porpoise, beluga, and false killer whale) have observed increases in hearing threshold levels when individuals received a warning sound prior to exposure to a relatively loud sound (Nachtigall and Supin, 2013, 2015; Nachtigall *et al.*, 2016a,b,c; Finneran, 2018; Nachtigall *et al.*, 2018). These studies suggest that captive animals have a mechanism to reduce hearing sensitivity prior to impending loud sounds. Hearing change was observed to be frequency dependent and Finneran (2018) suggests hearing attenuation occurs within the cochlea or auditory nerve. Based on these observations on captive odontocetes, the authors suggest that wild animals may have a mechanism to self-mitigate the impacts of noise exposure by dampening their hearing during prolonged exposures of loud sound, or if conditioned to anticipate intense sounds (Finneran, 2018; Nachtigall *et al.*, 2018).

Behavioral Disturbance

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately predisposed to respond to certain sounds in certain ways) (Southall *et al*., 2019). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), the similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.,* calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al*., 2007; DeRuiter *et al*., 2013). Individuals (of different age, gender, reproductive status, *etc.*) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.*, proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone. For example, Goldbogen *et al*. (2013b) demonstrated that individual behavioral state was critically important in determining response of blue whales to sonar, noting that some individuals engaged in deep (greater than 50 m) feeding behavior had greater dive responses than those in shallow feeding or non-feeding conditions. Some blue whales in the Goldbogen *et al*. (2013b) study that were engaged in shallow feeding behavior demonstrated no clear changes in diving or movement even when received levels were high (~160 dB *re 1μPa*) for exposures to 3-4 kHz sonar signals, while others showed a clear response at exposures at lower received levels of sonar and pseudorandom noise.

Studies by DeRuiter *et al.* (2012) indicate that variability of responses to acoustic stimuli depends not only on the species receiving the sound and the sound source, but also on the social, behavioral, or environmental contexts of exposure. Another study by DeRuiter *et al*. (2013) examined behavioral responses of Cuvier's beaked whales to MF sonar and found that whales responded strongly at low received levels (89-127 dB re 1μPa) by ceasing normal fluking and echolocation, swimming rapidly away, and extending both dive duration and subsequent non-foraging intervals when the sound source was 3.4-9.5 km away. Importantly, this study also showed that whales exposed to a similar range of received levels (78-106 dB re 1μPa) from distant sonar exercises (118 km away) did not elicit such responses, suggesting that context may moderate reactions. Thus, it is known that distance from the source can have an effect on behavioral response that is independent of the effect of received levels (*e.g.*, DeRuiter *et al*., 2013; Dunlop *et* *al*., 2017a; Dunlop *et al*., 2017b; Falcone *et al*., 2017; Dunlop *et al*., 2018; Southall *et al*., 2019a).

Ellison *et al*. (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. The authors recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (*i.e.*, is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal. Forney *et al*. (2017) also point out that an apparent lack of response (*e.g.*, no displacement or avoidance of a sound source) may not necessarily mean there is no cost to the individual or population, as some resources or habitats may be of such high value that animals may choose to stay, even when experiencing stress or hearing loss. Forney *et al*. (2017) recommend considering both the costs of remaining in an area of noise exposure such as TTS, PTS, or masking, which could lead to an increased risk of predation or other threats or a decreased capability to forage, and the costs of displacement, including potential increased risk of vessel strike, increased risks of predation or competition for resources, or decreased habitat suitable for foraging, resting, or socializing. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large spatial and temporal expanses. However, distance is one contextual factor for which data exist to quantitatively inform a take estimate, and the method for predicting Level B harassment in this rule does consider distance to the source. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure, where supporting information is available.

Friedlaender *et al*. (2016) provided the first integration of direct measures of prey distribution and density variables incorporated into across-individual analyses of behavior responses of blue whales to sonar, and demonstrated a five-fold increase in the ability to quantify variability in blue whale diving behavior. These results illustrate that responses evaluated without such measurements for foraging animals may be misleading, which again illustrates the context-dependent nature of the probability of response.

Exposure of marine mammals to sound sources can result in, but is not limited to, no response or any of the following observable responses: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al*., 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). More recent reviews (Nowacek *et al*., 2007; DeRuiter *et al*., 2012, 2013; Ellison *et al*., 2012; Gomez *et al*., 2016) address studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Gomez *et al*. (2016) conducted a review of the literature considering the contextual information of exposure in addition to received level and found that higher received levels were not always associated with more severe behavioral responses and vice versa. Southall *et al.* (2021) states that results demonstrate that some individuals of different species display clear yet varied responses, some of which have negative implications, while others appear to tolerate high levels, and that responses may not be fully predictable with simple acoustic exposure metrics (*e.g.*, received sound level). Rather, the authors state that differences among species and individuals along with contextual aspects of exposure (*e.g.*, behavioral state) appear to affect response probability. The following subsections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists, along with contextual factors.

Avoidance and Displacement

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al*., 1995). For example, gray whales or humpback whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from airgun surveys (Malme *et al*., 1984; Dunlop *et al*., 2018). Avoidance is qualitatively different from the flight response, but also differs in the magnitude of the response (*i.e.*, directed movement, rate of travel, etc.). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.*, Bowles *et al*., 1994; Goold, 1996; Stone *et al*., 2000; Morton and Symonds, 2002; Gailey *et al*., 2007; Dähne *et al*., 2013; Russel *et al.,* 2016; Malme *et al*., 1984). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.*, Blackwell *et al*., 2004; Bejder *et al*., 2006; Teilmann *et al*., 2006; Forney *et al.*, 2017). Avoidance of marine mammals during the construction of offshore wind facilities (specifically for impact pile driving) has been previously noted in the literature, with some significant variation in the effects. Most studies focused on harbor porpoises because it is one of the most common marine mammals in European waters (*e.g.*, Tougaard *et al.*, 2009; Dähne *et al.*, 2013; Thompson *et al.*, 2013; Russell *et al.*, 2016; Brandt *et al.*, 2018).

Available information on impacts to marine mammals from pile driving associated with offshore wind is limited to information on harbor porpoises and seals, as the vast majority of this research has occurred at European offshore wind projects where large whales and other odontocete species are uncommon. Harbor porpoises and harbor seals are considered to be behaviorally sensitive species (*e.g.*, Southall *et al.*, 2007) and the effects of wind farm construction in Europe on these species has been well documented. These species have received particular attention in European waters due to their abundance in the North Sea (Hammond *et al.*, 2002; Nachtsheim *et al.*, 2021). A summary of the literature on documented effects of wind farm construction on harbor porpoises and harbor seals is described below.

Brandt *et al.* (2016) summarized the effects of the construction of eight offshore wind projects within the German North Sea (*i.e.*, Alpha Ventus, BARD Offshore I, Borkum West II, DanTysk, Global Tech I, Meerwind Süd/Ost, Nordsee Ost, and Riffgat) between 2009 and 2013 on harbor porpoises, combining PAM data from 2010-2013 and aerial surveys from 2009-2013 with data on noise levels associated with pile driving. Results of the analysis revealed significant declines in harbor porpoise detections during pile driving when compared to 24-48 hours before pile driving began, with the magnitude of decline during pile driving clearly decreasing with increasing distances to the construction site. During the majority of projects, significant declines in detections (by at least 20 percent) were found within at least 5-10 km of the pile driving site, with declines at up to 20-30 km of the pile driving site documented in some cases. Similar results demonstrating the long-distance displacement of harbor porpoises (18-25 km) and harbor seals (up to 40 km) during impact pile driving have also been observed during the construction at multiple other European wind farms (Lucke *et al.*, 2012; Dähne *et al.*, 2013; Tougaard *et al.*, 2009; Haelters *et al.*, 2015; Bailey *et al.,* 2010).

While harbor porpoises and seals tend to move away from wind farm construction activities, the duration of displacement has been documented to be relatively temporary. In two studies at Horns Rev II using impact pile driving, harbor porpoises returned within

1-2 days following cessation of pile driving (Tougaard *et al.*, 2009, Brandt *et al.*, 2011). Similar recovery periods have been noted for harbor seals off of England during the construction of four wind farms (Carroll *et al.*, 2010; Hamre *et al.*, 2011; Hastie *et al.*, 2015; Russell *et al.,* 2016; Brasseur *et al.*, 2010). In some cases, an increase in harbor porpoise activity has been documented inside wind farm areas following construction (*e.g.*, Lindeboom *et al.*, 2011). Other studies have noted longer-term impacts after impact pile driving. Near Dogger Bank in Germany, harbor porpoises continued to avoid the area for over two years after construction began (Gilles *et al.* 2009). Approximately ten years after construction of the Nysted wind farm, harbor porpoise abundance had not recovered to the original levels previously observed, although echolocation activity was noted to have been increasing when compared to the previous monitoring period (Teilmann and Carstensen, 2012). However, overall, there are no indications of a population decline of harbor porpoises in European waters (*e.g.*, Brandt *et al*., 2016). Notably, where significant differences in displacement and return rates have been identified for these species, the occurrence of secondary project-specific influences such as use of mitigation measures (*e.g.*, bubble curtains, acoustic deterrent devices (ADDs)) or the manner in which species use the habitat in the project area are likely the driving factors of this variation.

NMFS notes the aforementioned studies from Europe involve pile driving of much smaller piles than Revolution Wind proposes to install and, therefore, we anticipate noise levels from impact pile driving to be louder. For this reason, we anticipate that the greater distances of displacement observed in harbor porpoises and harbor seals documented in Europe are more likely to occur off of Rhode Island. However, we do not anticipate any greater severity of response or population level consequences, similar to European findings. In many cases, harbor porpoises and harbor seals are resident to the areas where European wind farms have been constructed. However, harbor porpoises and harbor seals are seasonally present in the project area, predominantly occurring in winter, when impact pile driving would not occur. In summary, we anticipate that harbor porpoises and harbor seals would likely respond to pile driving by moving several kilometers away from the source; however, this impact would be temporary and would not impact any critical behaviors such as foraging or reproduction.

As noted previously, the only studies available on marine mammal responses to offshore wind-related pile driving have focused on species which are known to be more behaviorally sensitive to auditory stimuli than the other species that occur in the project area. Therefore, the documented behavioral responses of harbor porpoises and harbor seals to pile driving in Europe should be considered as a worst-case scenario in terms of the potential responses among all marine mammals to offshore pile driving, and these responses cannot reliably predict the responses that would occur in other marine mammal species.

Avoidance has been documented for other marine mammal species in response to playbacks. DeRuiter *et al*. (2013) noted that distance from a sound source may moderate marine mammal reactions in their study of Cuvier's beaked whales, which showed the whales swimming rapidly and silently away when a sonar signal was 3.4-9.5 km away, while showing no such reaction to the same signal when the signal was 118 km away, even though the received levels were similar. Tyack and Clark (1983) conducted playback studies of Surveillance Towed Array Sensor System (SURTASS) low frequency active (LFA) sonar in a gray whale migratory corridor off California. Similar to North Atlantic right whales, gray whales migrate close to shore (approximately +2 kms) and are low frequency hearing specialists. The LFA sonar source was placed within the gray whale migratory corridor (approximately 2 km offshore) and offshore of most, but not all, migrating whales (approximately 4 km offshore). These locations influenced received levels and distance to the source. For the inshore playbacks, not unexpectedly, when the source level of the playback was louder (*i.e.*, the louder the received level), whales avoided the source at greater distances. Specifically, when the source level was 170 dB rms and 178 dB rms, whales avoided the inshore source at ranges of several hundred meters, similar to avoidance responses reported by Malme *et al*. (1983, 1984). Whales exposed to source levels of 185 dB rms demonstrated avoidance levels at ranges of +1 km. While there was observed deflection from course, in no case did a whale abandon its migratory behavior.

One consequence of behavioral avoidance results in the altered energetic expenditure of marine mammals because energy is required to move and avoid surface vessels or the sound field associated with *e.g.*, active sonar (Frid and Dill, 2002). Most animals can avoid that energetic cost by swimming away at slow speeds or speeds that minimize the cost of transport (Miksis-Olds, 2006), as has been demonstrated in Florida manatees (Miksis-Olds, 2006). Those energetic costs increase, however, when animals shift from a resting state, which is designed to conserve an animal's energy, to an active state that consumes energy the animal would have conserved had it not been disturbed. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting to active behavioral states, which would imply that they incur an energy cost.

Forney *et al*. (2017) detailed the potential effects of noise on marine mammal populations with high site fidelity, including displacement and auditory masking, noting that a lack of observed response does not imply absence of fitness costs and that apparent tolerance of disturbance may have population-level impacts that are less obvious and difficult to document. Avoidance of overlap between disturbing noise and areas and/or times of particular importance for sensitive species may be critical to avoiding population-level impacts because (particularly for animals with high site fidelity) there may be a strong motivation to remain in the area despite negative impacts. Forney *et al*.

(2017) stated that, for these animals, remaining in a disturbed area may reflect a lack of alternatives rather than a lack of effects.

Flight Response

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.*, directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996; Frid and Dill, 2002). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves, 2008), and whether individuals are solitary or in groups may influence the response. The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, beaked whale strandings (Cox *et al*., 2006; D'Amico *et al*., 2009). Flight responses of marine mammals have been documented in response to mobile high intensity active sonar (*e.g.*, Tyack *et al*., 2011; DeRuiter *et al*., 2013; Wensveen *et al*., 2019), and more severe responses have been documented when sources are moving towards an animal or when they are surprised by unpredictable exposures (Watkins, 1986; Falcone *et al*., 2017). Generally speaking, however, marine mammals would be expected to be less likely to respond with a flight response to either stationery pile driving (which they can sense is stationery and predictable) or significantly lower-level HRG surveys, unless they are within the area ensonified above behavioral harassment thresholds at the moment the source is turned on (Watkins, 1986; Falcone *et al*., 2017). A flight response may also be possible in response to UXO/MEC detonation; however, given a detonation is instantaneous, only one detonation would occur on a given day, only 13 detonations may occur over 5 years, and the proposed mitigation and monitoring would result in any animals being far from the detonation (*i.e.*, the clearance zone extends 10 km from the UXO/MEC location), any flight response would be spatially and temporally limited.

Alteration of Diving and Foraging

Changes in dive behavior in response to noise exposure can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.*, Frankel and Clark, 2000; Costa *et al*., 2003; Ng and Leung, 2003; Nowacek *et al*., 2004; Goldbogen *et al.*, 2013a, 2013b). Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.*, foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (*e.g.*, increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek *et al*. (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. The alerting stimulus was in the form of an 18-minute exposure that included three 2-minute signals played three times sequentially. This stimulus was designed with the purpose of providing signals distinct to background noise that serve as localization cues. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise (both of which were signal types included in the playback experiment), highlighting the importance of the sound characteristics in producing a behavioral reaction. The alerting stimulus signals were relatively brief in duration, similar to the proposed Revolution Wind impact pile driving strikes, UXO detonation, and some HRG acoustic sources. Although source levels for

Revolution Wind's activities may exceed the source level of the alerting stimulus, proposed mitigation strategies (further described in the **Proposed Mitigation** section) would reduce the severity of any responses to the activities. Converse to North Atlantic right whale behavior, Indo-Pacific humpback dolphins have been observed diving for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach, and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low-frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa *et al*., 2003). They did, however, produce subtle effects that varied in direction and degree among the individual elephant seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.*, bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.*, Croll *et al.*, 2001; Nowacek *et al*., 2004; Madsen *et al.*, 2006a; Yazvenko *et al*., 2007; Southall *et al*., 2019b). An understanding of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal can facilitate the assessment of whether foraging disruptions are likely to incur fitness consequences (Goldbogen *et al.,* 2013b; Farmer *et al*., 2018; Pirotta *et al*., 2018; Southall *et al*., 2019; Pirotta *et al*., 2021).

Impacts on marine mammal foraging rates from noise exposure have been documented, though there is little data regarding the impacts of offshore turbine construction specifically. Several broader examples follow, and it is reasonable to expect that exposure to noise produced during the 5-years the proposed rule would be effective could have similar impacts.

Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to air gun arrays at received levels in the range 140-160 dB at distances of 7-13 km, following a phase-in of sound intensity and full array exposures at 1-13 km (Madsen *et al*., 2006a; Miller *et al*., 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the air guns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were six percent lower during exposure than control periods (Miller *et al*., 2009). Miller *et al*. (2009) noted that more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior. We note that the water depths in the project area preclude deep foraging dives for any marine mammal species and sperm whales are not expected to be foraging in the area. However, some temporary disruption to marine mammals that may be foraging in the project area is likely to occur.

Balaenopterid whales (fin and blue whales) exposed to moderate low-frequency active sonar (signals similar to the ATOC sound source) demonstrated no variation in foraging activity (Croll *et al.*, 2001), whereas five out of six North Atlantic right whales exposed to the alerting stimulus (described previously) interrupted their foraging dives (Nowacek *et al.*, 2004). Although the received SPLs were similar in the two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. Source levels generated during Revolution Wind's activities would generally meet or exceed the source levels of the signals described by Nowacek *et al*. (2004) (173 dB rms at 1 m) and Croll *et al*. (2001) (155 dB rms increased at 10dB intervals) and noise generated by Revolution Wind's activities would overlap in frequency with the described signals. Blue whales exposed to mid-frequency sonar in the Southern California Bight were less likely to produce low-frequency calls usually associated with feeding behavior (Melcón *et al*., 2012). However, Melcón *et al*. (2012) were unable to determine if suppression of low frequency calls reflected a change in their feeding performance or abandonment of foraging behavior and indicated that implications of the documented responses are unknown. Further, it is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. Results from the 2010-2011 field season of a behavioral response study in Southern California waters indicated that, in some cases and at low received levels, tagged blue whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall *et al*., 2011, 2012, 2019).

Information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal will help better inform a determination of whether foraging disruptions incur fitness consequences. Foraging strategies may impact foraging efficiency, such as by reducing foraging effort and increasing success in prey detection and capture, in turn promoting fitness and allowing individuals to better compensate for foraging disruptions. Surface feeding blue whales did not show a change in behavior in response to mid-frequency simulated and real sonar sources with received levels between 90 and 179 dB re 1 μPa, but deep feeding and non-feeding whales showed temporary reactions, including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior (DeRuiter *et al*., 2017; Goldbogen *et al*., 2013b; Sivle *et al*., 2015). Goldbogen *et al*. (2013b) indicate that disruption of feeding and displacement could impact individual fitness and health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since unconsumed prey would likely still be available in the environment in most cases following the cessation of acoustic exposure.

Similarly, while the rates of foraging lunges decrease in humpback whales due to sonar exposure, there was variability in the response across individuals, with one animal ceasing to forage completely and another animal starting to forage during the exposure (Sivle *et al*., 2016). In addition, almost half of the animals that demonstrated avoidance were foraging before the exposure, but the others were not; the animals that avoided while not feeding responded at a slightly lower received level and greater distance than those that were feeding (Wensveen *et al*., 2017). These findings indicate the behavioral state of the animal and foraging strategies play a role in the type and severity of a behavioral response. For example, when the prey field was mapped and used as a covariate in examining how behavioral state of blue whales is influenced by mid-frequency sound, the response in blue whale deep-feeding behavior was even more apparent, reinforcing the need for contextual variables to be included when assessing behavioral responses (Friedlaender *et al*., 2016).

Breathing

Respiration naturally varies with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey *et al.*, 2007). Studies with captive harbor porpoises show increased respiration rates upon introduction of acoustic alarms (Kastelein *et al*., 2001; Kastelein *et al*., 2006a) and emissions for underwater data transmission (Kastelein *et al*., 2005). However, exposure to the same acoustic alarm of a striped dolphin under the same conditions did not elicit a response (Kastelein *et al*., 2006a), again highlighting the importance of understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Vocalizations (Also see the *Auditory Masking* section)

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, production of echolocation clicks, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result directly from increased vigilance (also see the *Potential Effects of Behavioral Disturbance on Marine Mammal Fitness* section) or a startle response, or from a need to compete with an increase in background noise (see Erbe *et al.,* 2016 review on communication masking), the latter of which is described more in the *Auditory Masking* section below.

For example, in the presence of potentially masking signals, humpback whales and killer whales have been observed to increase the length of their vocalizations (Miller *et al*., 2000; Fristrup *et al*., 2003; Foote *et al.*, 2004) and blue increased song production (Di Iorio and Clark, 2010), while North Atlantic right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al*., 2007). In some cases, animals may cease or reduce sound production during production of aversive signals (Bowles *et al*., 1994; Thode *et al*., 2020; Cerchio *et al*., 2014; McDonald *et al.,* 1995).

Orientation

A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Habituation and Sensitization

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al*., 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a “progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,” rather than as, more generally, moderation in response to human disturbance having a neutral or positive outcome (Bejder *et al*., 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Both habituation and sensitization require an ongoing learning process. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al*., 1995; U.S. National Research Council (NRC), 2003; Wartzok *et al*., 2003; Southall *et al*., 2019b). Controlled experiments with captive marine mammals have shown pronounced behavioral reactions, including avoidance of loud sound sources (*e.g.*, Ridgway *et al*., 1997; Finneran *et al*., 2003; Houser *et al*., 2013a,b; Kastelein *et al*., 2018). Observed responses of wild marine mammals to loud impulsive sound sources (typically airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al*., 1995; Nowacek *et al*., 2007; Tougaard *et al.*, 2009; Brandt *et al*., 2011, Brandt *et al*., 2012, Dähne *et al*., 2013; Brandt *et al*., 2014; Russell *et al*., 2016; Brandt *et al*., 2018). However, many delphinids approach low-frequency airgun source vessels with no apparent discomfort or obvious behavioral change (*e.g.*, Barkaszi *et al*., 2012), indicating the potential importance of frequency output in relation to the species' hearing sensitivity.

Stress Response

An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.*, Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.*, Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al*., 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and "distress" is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well studied through controlled experiments, and for both laboratory and free-ranging animals (*e.g.*, Holberton *et al*., 1996; Hood *et al*., 1998; Jessop *et al*., 2003; Krausman *et al*., 2004; Lankford *et al*., 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al*., 2002b) and, more rarely, studied in wild populations (*e.g.*, Lusseau and Bejder, 2007; Romano *et al*., 2002a). For example, Rolland *et al*. (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. Lusseau and Bejder (2007) present data from three long-term studies illustrating the connections between disturbance from whale-watching boats and population-level effects in cetaceans. In Shark Bay, Australia, the abundance of bottlenose dolphins was compared within adjacent control and tourism sites over three consecutive 4.5-year periods of increasing tourism levels. Between the second and third time periods, in which tourism doubled, dolphin abundance decreased by 15 percent in the tourism area and did not change significantly in the control area. In Fiordland, New Zealand, two populations (Milford and Doubtful Sounds) of bottlenose dolphins with tourism levels that differed by a factor of seven were observed and significant increases in traveling time and decreases in resting time were documented for both. Consistent short-term avoidance strategies were observed in response to tour boats until a threshold of disturbance was reached (average 68 minutes between interactions), after which the response switched to a longer-term habitat displacement strategy. For one population, tourism only occurred in a part of the home range. However, tourism occurred throughout the home range of the Doubtful Sound population, and once boat traffic increased beyond the 68-minute threshold (resulting in abandonment of their home range/preferred habitat), reproductive success drastically decreased (increased stillbirths) and abundance decreased significantly (from 67 to 56 individuals in a short period).

These and other studies lead to a reasonable expectation that some marine mammals would experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as "distress." In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003, 2017).

Auditory Masking

Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.*, those used for intraspecific communication and social interactions, prey detection, predator avoidance, or navigation) (Richardson *et al*., 1995; Erbe and Farmer, 2000; Tyack, 2000; Erbe *et al*., 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.*, snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.*, shipping, sonar, pile driving) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.*, signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.*, sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age, or TTS hearing loss), and existing ambient noise and propagation conditions. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations. Masking can lead to behavioral changes including vocal changes (*e.g.*, Lombard effect, increasing amplitude, or changing frequency), cessation of foraging or lost foraging opportunities, and leaving an area, for both signalers and receivers, in an attempt to compensate for noise levels (Erbe *et al*., 2016) or because sounds that would typically have triggered a behavior were not detected. In humans, significant masking of tonal signals occurs as a result of exposure to noise in a narrow band of similar frequencies. As the sound level increases, though, the detection of frequencies above those of the masking stimulus decreases also. This principle is expected to apply to marine mammals as well because of common biomechanical cochlear properties across taxa.

Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting or altering critical behaviors. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which only occurs during the sound exposure. Because masking (without resulting in threshold shift) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.*, Clark *et al*., 2009; Matthews *et al.*, 2016) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.*, Miller *et al*., 2000; Foote *et al*., 2004; Parks *et al*., 2007; Di Iorio and Clark, 2009; Holt *et al*., 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al*., 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.*, Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.*, Branstetter *et al.*, 2013; Cholewiak *et al.,* 2018).

The echolocation calls of toothed whales are subject to masking by high-frequency sound. Studies on captive odontocetes by Au *et al*. (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (*e.g.*, adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high-frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use to communicate (Zaitseva *et al*., 1980). A study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

Impacts on signal detection, measured by masked detection thresholds, are not the only important factors to address when considering the potential effects of masking. As marine mammals use sound to recognize conspecifics, prey, predators, or other biologically significant sources (Branstetter *et al*., 2016), it is also important to understand the impacts of masked recognition thresholds (often called "informational masking"). Branstetter *et al*., 2016 measured masked recognition thresholds for whistle-like sounds of bottlenose dolphins and observed that they are approximately 4 dB above detection thresholds (energetic masking) for the same signals. Reduced ability to recognize a conspecific call or the acoustic signature of a predator could have severe negative impacts. Branstetter *et al*., 2016 observed that if "quality communication" is set at 90 percent recognition the output of communication space models (which are based on 50 percent detection) would likely result in a significant decrease in communication range.

As marine mammals use sound to recognize predators (Allen *et al*., 2014; Cummings and Thompson, 1971; Curé *et al*., 2015; Fish and Vania, 1971), the presence of masking noise may also prevent marine mammals from responding to acoustic cues produced by their predators, particularly if it occurs in the same frequency band. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by mammal-eating killer whales. The seals acoustically discriminate between the calls of mammal-eating and fish-eating killer whales (Deecke *et al*., 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls. Similarly, sperm whales (Curé *et al.*, 2016; Isojunno *et al*., 2016), long-finned pilot whales (Visser *et al.*, 2016), and humpback whales (Curé *et al.*, 2015) changed their behavior in response to killer whale vocalization playbacks; these findings indicate that some recognition of predator cues could be missed if the killer whale vocalizations were masked. The potential effects of masked predator acoustic cues depends on the duration of the masking noise and the likelihood of a marine mammal encountering a predator during the time that detection and recognition of predator cues are impeded.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio.

Masking affects both senders and receivers of acoustic signals and, at higher levels and longer duration, can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009; Cholewiak *et al*., 2018). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.*, from commercial vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

In addition to making it more difficult for animals to perceive and recognize acoustic cues in their environment, anthropogenic sound presents separate challenges for animals that are vocalizing. When they vocalize, animals are aware of environmental conditions that affect the “active space” (or communication space) of their vocalizations, which is the maximum area within which their vocalizations can be detected before it drops to the level of ambient noise (Brenowitz, 2004; Brumm *et al*., 2004; Lohr *et al*., 2003). Animals are also aware of environmental conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which is more important than simply detecting that a vocalization is occurring (Brenowitz, 1982; Brumm *et al*., 2004; Dooling, 2004; Marten and Marler, 1977; Patricelli *et al*., 2006). Most species that vocalize have evolved with an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability/distinguishability of their vocalizations in the face of temporary changes in background noise (Brumm *et al*., 2004; Patricelli *et al*., 2006). Vocalizing animals can make adjustments to vocalization characteristics such as the frequency structure, amplitude, temporal structure, and temporal delivery (repetition rate), or ceasing to vocalize.

Many animals will combine several of these strategies to compensate for high levels of background noise. Anthropogenic sounds that reduce the signal-to-noise ratio of animal vocalizations, increase the masked auditory thresholds of animals listening for such vocalizations, or reduce the active space of an animal's vocalizations impair communication between animals. Most animals that vocalize have evolved strategies to compensate for the effects of short-term or temporary increases in background or ambient noise on their songs or calls. Although the fitness consequences of these vocal adjustments are not directly known in all instances, like most other trade-offs animals must make, some of these strategies probably come at a cost (Patricelli *et al*., 2006; Noren *et al*., 2017; Noren *et al*., 2020). Shifting songs and calls to higher frequencies may also impose energetic costs (Lambrechts, 1996).

Marine mammals are also known to make vocal changes in response to anthropogenic noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying (see the following for examples: Gordon *et al*., 2003; Di Iorio and Clark, 2010; Hatch *et al*., 2012; Holt *et al*., 2008; Holt *et al*., 2011; Lesage *et al*., 1999; McDonald *et al*., 2009; Parks *et al*., 2007; Risch *et al*., 2012; Rolland *et al*., 2012), as well as changes in the natural acoustic environment (Dunlop *et al*., 2014). Vocal changes can be temporary, or can be persistent. For example, model simulation suggests that the increase in starting frequency for the North Atlantic right whale upcall over the last 50 years resulted in increased detection ranges between right whales. The frequency shift, coupled with an increase in call intensity by 20 dB, led to a call detectability range of less than 3 km to over 9 km (Tennessen and Parks, 2016). Holt *et al*. (2008) measured killer whale call source levels and background noise levels in the one to 40 kHz band and reported that the whales increased their call source levels by one dB SPL for every one dB SPL increase in background noise level. Similarly, another study on St. Lawrence River belugas reported a similar rate of increase in vocalization activity in response to passing vessels (Scheifele *et al*., 2005). Di Iorio and Clark (2010) showed that blue whale calling rates vary in association with seismic sparker survey activity, with whales calling more on days with surveys than on days without surveys. They suggested that the whales called more during seismic survey periods as a way to compensate for the elevated noise conditions.

In some cases, these vocal changes may have fitness consequences, such as an increase in metabolic rates and oxygen consumption, as observed in bottlenose dolphins when increasing their call amplitude (Holt *et al*., 2015). A switch from vocal communication to physical, surface-generated sounds such as pectoral fin slapping or breaching was observed for humpback whales in the presence of increasing natural background noise levels, indicating that adaptations to masking may also move beyond vocal modifications (Dunlop *et al*., 2010).

While these changes all represent possible tactics by the sound-producing animal to reduce the impact of masking, the receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a quieter location, or reducing self-noise from hydrodynamic flow by remaining still. The temporal structure of noise (*e.g.*, amplitude modulation) may also provide a considerable release from masking through co-modulation masking release (a reduction of masking that occurs when broadband noise, with a frequency spectrum wider than an animal's auditory filter bandwidth at the frequency of interest, is amplitude modulated) (Branstetter and Finneran, 2008; Branstetter *et al*., 2013). Signal type (*e.g.*, whistles, burst-pulse, sonar clicks) and spectral characteristics (*e.g.*, frequency modulated with harmonics) may further influence masked detection thresholds (Branstetter *et al*., 2016; Cunningham *et al*., 2014).

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as vessels. Several studies have shown decreases in marine mammal communication space and changes in behavior as a result of the presence of vessel noise. For example, right whales were observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al*., 2007) as well as increasing the amplitude (intensity) of their calls (Parks, 2009; Parks *et al*., 2011). Clark *et al*. (2009) observed that right whales' communication space decreased by up to 84 percent in the presence of vessels. Cholewiak *et al*. (2018) also observed loss in communication space in Stellwagen National Marine Sanctuary for North Atlantic right whales, fin whales, and humpback whales with increased ambient noise and shipping noise. Although humpback whales off Australia did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected based on source level changes to wind noise, potentially indicating some signal masking (Dunlop, 2016). Multiple delphinid species have also been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic noise and reduced communication space (for examples see: Holt *et al*., 2008; Holt *et al.*, 2011; Gervaise *et al*., 2012; Williams *et al.*, 2013; Hermannsen *et al*., 2014; Papale *et al*., 2015; Liu *et al*., 2017). While masking impacts are not a concern from lower intensity, higher frequency HRG surveys, some degree of masking would be expected in the vicinity of turbine pile driving and concentrated support vessel operation. However, pile driving is an intermittent sound and would not be continuous throughout a day.

Potential Effects of Behavioral Disturbance on Marine Mammal Fitness

The different ways that marine mammals respond to sound are sometimes indicators of the ultimate effect that exposure to a given stimulus will have on the well-being (survival, reproduction, etc.) of an animal. There is little quantitative marine mammal data relating the exposure of marine mammals from sound to effects on reproduction or survival, though data exists for terrestrial species to which we can draw comparisons for marine mammals. Several authors have reported that disturbance stimuli may cause animals to abandon nesting and foraging sites (Sutherland and Crockford, 1993); may cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan *et al*., 1996; Feare, 1976; Mullner *et al*., 2004); or may cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill, 2002). Each of these studies addressed the consequences of animals shifting from one behavioral state (*e.g.*, resting or foraging) to another behavioral state (*e.g.*, avoidance or escape behavior) because of human disturbance or disturbance stimuli.

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called “attentional capture” occurs when a stimulus (usually a stimulus that an animal is not concentrating on or attending to) “captures” an animal's attention. This shift in attention can occur consciously or subconsciously (for example, when an animal hears sounds that it associates with the approach of a predator) and the shift in attention can be sudden (Dukas, 2002; van Rij, 2007). Once a stimulus has captured an animal's attention, the animal can respond by ignoring the stimulus, assuming a “watch and wait” posture, or treat the stimulus as a disturbance and respond accordingly, which includes scanning for the source of the stimulus or “vigilance” (Cowlishaw *et al*., 2004).

Vigilance is an adaptive behavior that helps animals determine the presence or absence of predators, assess their distance from conspecifics, or to attend cues from prey (Bednekoff and Lima, 1998; Treves, 2000). Despite those benefits, however, vigilance has a cost of time; when animals focus their attention on specific environmental cues, they are not attending to other activities such as foraging or resting. These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al*., 2002; Purser and Radford, 2011). Animals will spend more time being vigilant, which may translate to less time foraging or resting, when disturbance stimuli approach them more directly, remain at closer distances, have a greater group size (*e.g.*, multiple surface vessels), or when they co-occur with times that an animal perceives increased risk (*e.g.*, when they are giving birth or accompanied by a calf).

Chronic disturbance can cause population declines through reduction of fitness (*e.g.*, decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.*, Harrington and Veitch, 1992; Daan *et al*., 1996; Bradshaw *et al*., 1998). For example, Madsen (1994) reported that pink-footed geese (*Anser brachyrhynchus*) in undisturbed habitat gained body mass and had about a 46 percent reproductive success rate compared with geese in disturbed habitat (being consistently scared off the fields on which they were foraging) which did not gain mass and had a 17 percent reproductive success rate. Similar reductions in reproductive success have been reported for mule deer (*Odocoileus hemionus*) disturbed by all-terrain vehicles (Yarmoloy *et al*., 1988), caribou (*Rangifer tarandus caribou*) disturbed by seismic exploration blasts (Bradshaw *et al*., 1998), and caribou disturbed by low-elevation military jet fights (Luick *et al*., 1996, Harrington and Veitch, 1992). Similarly, a study of elk (*Cervus elaphus*) that were disturbed experimentally by pedestrians concluded that the ratio of young to mothers was inversely related to disturbance rate (Phillips and Alldredge, 2000).

The primary mechanism by which increased vigilance and disturbance appear to affect the fitness of individual animals is by disrupting an animal's time budget and, as a result, reducing the time they might spend foraging and resting (which increases an animal's activity rate and energy demand while decreasing their caloric intake/energy).

In a study of northern resident killer whales off Vancouver Island, exposure to boat traffic was shown to reduce foraging opportunities and increase traveling time (Williams *et al.,* 2006). A simple bioenergetics model was applied to show that the reduced foraging opportunities equated to a decreased energy intake of 18 percent, while the increased traveling incurred an increased energy output of 3-4 percent, which suggests that a management action based on avoiding interference with foraging might be particularly effective.

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant for fitness if they last more than one diel cycle or recur on subsequent days (Southall *et al*., 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al*., 2007). It is important to note the difference between behavioral reactions lasting or recurring over multiple days and anthropogenic activities lasting or recurring over multiple days. For example, just because certain activities last for multiple days does not necessarily mean that individual animals will be either exposed to those activity-related stressors (*i.e.*, sonar) for multiple days or further, exposed in a manner that would result in sustained multi-day substantive behavioral responses; however, special attention is warranted where longer-duration activities overlay areas in which animals are known to congregate for longer durations for biologically important behaviors.

Stone (2015a) reported data from at-sea observations during 1,196 airgun surveys from 1994 to 2010. When large arrays of airguns were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior, with indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding less often when large arrays were active. Behavioral observations of gray whales during an air gun survey monitored whale movements and respirations pre-, during-, and post-seismic survey (Gailey *et al*., 2016). Behavioral state and water depth were the best 'natural' predictors of whale movements and respiration and, after considering natural variation, none of the response variables were significantly associated with survey or vessel sounds.

In order to understand how the effects of activities may or may not impact species and stocks of marine mammals, it is necessary to understand not only what the likely disturbances are going to be, but how those disturbances may affect the reproductive success and survivorship of individuals, and then how those impacts to individuals translate to population-level effects. Following on the earlier work of a committee of the U.S. National Research Council (NRC, 2005), New *et al*. (2014), in an effort termed the

Potential Consequences of Disturbance (PCoD), outline an updated conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics. In this framework, behavioral and physiological changes can have direct (acute) effects on vital rates, such as when changes in habitat use or increased stress levels raise the probability of mother-calf separation or predation; they can have indirect and long-term (chronic) effects on vital rates, such as when changes in time/energy budgets or increased disease susceptibility affect health, which then affects vital rates; or they can have no effect to vital rates (New *et al*., 2014). In addition to outlining this general framework and compiling the relevant literature that supports it, the authors chose four example species for which extensive long-term monitoring data exist (southern elephant seals, North Atlantic right whales, *Ziphiidae* beaked whales, and bottlenose dolphins) and developed state-space energetic models that can be used to effectively forecast longer-term, population-level impacts from behavioral changes. While these are very specific models with very specific data requirements that cannot yet be applied broadly to project-specific risk assessments for the majority of species, they are a critical first step towards being able to quantify the likelihood of a population level effect.

Since New *et al.* (2014), several publications have described models developed to examine the long-term effects of environmental or anthropogenic disturbance of foraging on various life stages of selected species (sperm whale, Farmer *et al*. (2018); California sea lion, McHuron *et al.* (2018); blue whale, Pirotta *et al*. (2018a)). These models continue to add to refinement of the approaches to the PCoD framework. Such models also help identify what data inputs require further investigation. Pirotta *et al.* (2018b) provides a review of the PCoD framework with details on each step of the process and approaches to applying real data or simulations to achieve each step.

New *et al.* (2020) found that closed populations of dolphins could not withstand a higher probability of disturbance, compared to open populations with no limitation on food. Two bottlenose dolphin populations in Australia were also modeled over 5 years against a number of disturbances (Reed *et al.*, 2020), and results indicated that habitat/noise disturbance had little overall impact on population abundances in either location, even in the most extreme impact scenarios modeled. By integrating different sources of data (*e.g.*, controlled exposure data, activity monitoring, telemetry tracking, and prey sampling) into a theoretical model to predict effects from sonar on a blue whale's daily energy intake, Pirotta *et al.* (2021) found that tagged blue whales' activity budgets, lunging rates, and ranging patterns caused variability in their predicted cost of disturbance. Dunlop *et al*. (2021) modeled migrating humpback whale mother-calf pairs in response to seismic surveys using both a forwards and backwards approach. While a typical forwards approach can determine if a stressor would have population-level consequences, Dunlop *et al.* demonstrated that working backwards through a PCoD model can be used to assess the "worst case" scenario for an interaction of a target species and stressor. This method may be useful for future management goals when appropriate data becomes available to fully support the model. Harbor porpoise movement and foraging were modeled for baseline periods and then for periods with seismic surveys as well; the models demonstrated that the seasonality of the seismic activity was an important predictor of impact (Gallagher *et al.*, 2021).

Nearly all PCoD studies and experts agree that infrequent exposures of a single day or less are unlikely to impact individual fitness, l*et al*one lead to population level effects (Booth *et al*., 2016; Booth *et al*., 2017; Christiansen and Lusseau 2015; Farmer *et al*., 2018; Wilson *et al*., 2020; Harwood and Booth 2016; King *et al*., 2015; McHuron *et al*., 2018; NAS 2017; New *et al*., 2014; Pirotta *et al*., 2018; Southall *et al*., 2007; Villegas-Amtmann *et al*., 2015). NMFS expects that any behavioral responses that would occur due to animals being exposed to construction activity would be temporary, with behavior returning to a baseline state shortly after the acoustic stimuli ceases. Given this, and NMFS' evaluation of the available PCoD studies, any such behavioral responses are not expected to impact individual animals' health or have effects on individual animals' survival or reproduction, thus no detrimental impacts at the population level are anticipated.

Potential Effects from Explosive Sources

With respect to the noise from underwater explosives, the same acoustic-related impacts described above apply and are not repeated here. Noise from explosives can cause hearing impairment if an animal is close enough to the sources; however, because noise from an explosion is discrete, lasting less than approximately one second, no behavioral impacts below the TTS threshold are anticipated considering that Revolution Wind would not detonate more than one UXO/MEC per day (and no more than 13 only throughout the life of the proposed rule). This section focuses on the pressure-related impacts of underwater explosives, including physiological injury and mortality.

Underwater explosive detonations send a shock wave and sound energy through the water and can release gaseous by-products, create an oscillating bubble, or cause a plume of water to shoot up from the water surface. The shock wave and accompanying noise are of most concern to marine animals. Depending on the intensity of the shock wave and size, location, and depth of the animal, an animal can be injured, killed, suffer non-lethal physical effects, experience hearing-related effects with or without behavioral responses, or exhibit temporary behavioral responses or tolerance from hearing the blast sound. Generally, exposures to higher levels of impulse and pressure levels would result in greater impacts to an individual animal.

Injuries resulting from a shock wave take place at boundaries between tissues of different densities. Different velocities are imparted to tissues of different densities, and this can lead to their physical disruption. Blast effects are greatest at the gas-liquid interface (Landsberg, 2000). Gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Goertner, 1982; Hill, 1978; Yelverton *et al*., 1973). Intestinal walls can bruise or rupture, with subsequent hemorrhage and escape of gut contents into the body cavity. Less severe gastrointestinal tract injuries include contusions, petechiae (small red or purple spots caused by bleeding in the skin), and slight hemorrhaging (Yelverton *et al*., 1973).

Because the ears are the most sensitive to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound-related damage associated with sound energy from detonations can be theoretically distinct from injury from the shock wave, particularly farther from the explosion. If a noise is audible to an animal, it has the potential to damage the animal's hearing by causing decreased sensitivity (Ketten, 1995). Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source and are not, technically, pure acoustic trauma (Ketten, 1995). Sublethal impacts include hearing loss, which is caused by exposures to perceptible sounds. Severe damage (from the shock wave) to the ears includes tympanic membrane rupture, fracture of the ossicles, and damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear. Moderate injury implies partial hearing loss due to tympanic membrane rupture and blood in the middle ear. Permanent hearing loss also can occur when the hair cells are damaged by one very loud event, as well as by prolonged exposure to a loud noise or chronic exposure to noise. The level of impact from blasts depends on both an animal's location and, at outer zones, on its sensitivity to the residual noise (Ketten, 1995).

Given the mitigation measures proposed, it is unlikely that any of the more serious injuries or mortality discussed above would result from any UXO/MEC detonation that Revolution Wind might need to undertake. PTS, TTS, and brief startle reactions are the most likely impacts to result from this activity.

Potential Effects of Vessel Strike

Vessel collisions with marine mammals, also referred to as vessel strikes or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. Lethal interactions are typically associated with large whales, which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al*., 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al*., 2010; Gende *et al.*, 2011).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.*, the sperm whale). In addition, some baleen whales seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al*., 2004). These species are primarily large, slow moving whales. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike occurs and, if so, whether it results in injury, serious injury, or mortality (Knowlton and Kraus, 2001;

Laist *et al*., 2001; Jensen and Silber, 2003; Pace and Silber, 2005; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). In assessing records in which vessel speed was known, Laist *et al*. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these 58 cases, 39 (or 67 percent) resulted in serious injury or death (19 of those resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Higher speeds during collisions result in greater force of impact and also appear to increase the chance of severe injuries or death. While modeling studies have suggested that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne 1999; Knowlton *et al*., 1995), this is inconsistent with Silber *et al*. (2010), which demonstrated that there is no such relationship (*i.e.*, hydrodynamic forces are independent of speed).

In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 knots. The chances of a lethal injury decline from approximately 80 percent at 15 knots to approximately 20 percent at 8.6 knots. At speeds below 11.8 knots, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 knots.

The Jensen and Silber (2003) report notes that the Large Whale Ship Strike Database represents a minimum number of collisions, because the vast majority probably goes undetected or unreported. In contrast, Revolution Wind's personnel are likely to detect any strike that does occur because of the required personnel training and lookouts, along with the inclusion of PSOs (as described in the **Proposed Mitigation** section), and they are required to report all ship strikes involving marine mammals.

NMFS is not aware of any documented vessel strikes of marine mammals by Revolution Wind or Ørsted during previous site characterization surveys. Given the extensive mitigation and monitoring measures (see the **Proposed Mitigation** and **Proposed Monitoring and Reporting** section) that would be required of Revolution Wind, NMFS believes that vessel strike of any marine mammal is not likely to occur, nor are we proposing to authorize take from vessel strikes.

Marine Mammal Habitat

Revolution Wind's proposed construction activities could potentially affect marine mammal habitat through the introduction of impacts to the prey species of marine mammals, acoustic habitat (sound in the water column), and water quality.

The presence of structures such as wind turbines is likely to result in both local and broader oceanographic effects. However, the scale of impacts is difficult to predict and may vary from hundreds of meters for local individual turbine impacts (Schultze *et al.*, 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers (Christiansen *et al.*, 2022).

Effects on Prey

Sound may affect marine mammals through impacts on the abundance, behavior, or distribution of prey species (*e.g.*, crustaceans, cephalopods, fish, and zooplankton). Marine mammal prey varies by species, season, and location and, for some, is not well documented. Here, we describe studies regarding the effects of noise on known marine mammal prey.

Fish utilize the soundscape and components of sound in their environment to perform important functions such as foraging, predator avoidance, mating, and spawning (*e.g.*, Zelick *et al.*, 1999; Fay, 2009). The most likely effects on fishes exposed to loud, intermittent, low-frequency sounds are behavioral responses (*i.e.*, flight or avoidance). Short duration, sharp sounds (such as pile driving or air guns) can cause overt or subtle changes in fish behavior and local distribution. The reaction of fish to acoustic sources depends on the physiological state of the fish, past exposures, motivation (*e.g.*, feeding, spawning, migration), and other environmental factors. Key impacts to fishes may include behavioral responses, hearing damage, barotrauma (pressure-related injuries), and mortality. While it is clear that the behavioral responses of individual prey, such as displacement or other changes in distribution, can have direct impacts on the foraging success of marine mammals, the effects on marine mammals of individual prey that experience hearing damage, barotrauma, or mortality is less clear, though obviously population scale impacts that meaningfully reduce the amount of prey available could have more serious impacts.

In terms of physiology, multiple scientific studies have documented a lack of mortality or physiological effects to fish from exposure to low- and mid-frequency sonar and other sounds (Halvorsen *et al.*, 2012; Jørgensen *et al.*, 2005; Juanes *et al.*, 2017; Kane *et al.*, 2010; Kvadsheim and Sevaldsen, 2005; Popper *et al.*, 2007; Popper *et al.*, 2016; Watwood *et al.*, 2016). Techer *et al*. (2017) exposed carp in floating cages for up to 30 days to low-power 23 and 46 kHz source without any significant physiological response. Other studies have documented either a lack of TTS in species whose hearing range cannot perceive sonar, or for those species that could perceive sonar-like signals, any TTS experienced would be recoverable (Halvorsen *et al*., 2012; Ladich and Fay, 2013; Popper and Hastings, 2009a, 2009b; Popper *et al*., 2014; Smith, 2016). Only fishes that have specializations that enable them to hear sounds above about 2,500 Hz (2.5 kHz) such as herring (Halvorsen *et al*., 2012; Mann *et al*., 2005; Mann, 2016; Popper *et al*., 2014) would have the potential to receive TTS or exhibit behavioral responses from Revolution Wind's activities.

In terms of behavioral responses, Watwood *et al*. (2016) documented no behavioral responses by reef fish after exposure to mid-frequency active sonar. Doksaeter *et al*. (2009, 2012) reported no behavioral responses to mid-frequency sonar (such as naval sonar) by Atlantic herring; specifically, no escape reactions (vertically or horizontally) were observed in free swimming herring exposed to mid-frequency sonar transmissions. Based on these results (Doksaeter *et al*., 2009; Doksaeter *et al*., 2012; Sivle *et al*., 2012), Sivle *et al*. (2014) created a model in order to report on the possible population-level effects on Atlantic herring from active sonar. The authors concluded that the use of sonar poses little risk to populations of herring regardless of season, even when the herring populations are aggregated and directly exposed to sonar. Finally, Bruintjes *et al*. (2016) commented that fish exposed to any short-term noise within their hearing range might initially startle, but would quickly return to normal behavior.

Occasional behavioral reactions to activities that produce underwater noise sources are unlikely to cause long-term consequences for individual fish or populations. The most likely impact to fish from impact and vibratory pile driving activities in the RWF would be temporary behavioral avoidance of the area. Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in the nearby vicinity. The duration of fish avoidance of an area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the expected short daily duration of individual pile driving events and the relatively small area being affected.

SPLs of sufficient strength have been known to cause injury to fish and fish mortality. However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.* (2012a) showed that a TTS of 4-6 dB was recoverable within 24 hours for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long. Injury caused by barotrauma can range from slight to severe and can cause death, and is most likely for fish with swim bladders. Barotrauma injuries have been documented during controlled exposure to impact pile driving (Halvorsen *et al.*, 2012b; Casper *et al.*, 2013). As described in the **Proposed Mitigation** section below, Revolution Wind would utilize a sound attenuation device which would reduce potential for injury to marine mammal prey. Other fish that experience hearing loss as a result of exposure to explosions and impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. However, PTS has not been known to occur in fishes and any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Popper *et al.*, 2005; Popper *et al.*, 2014; Smith *et al.*, 2006).

It is also possible for fish to be injured or killed by an explosion from UXO/MEC detonation. The shock wave from an underwater explosion is lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin and Hempen, 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species

(Keevin and Hempen, 1997; Wright, 1982). Species with gas-filled organs are more susceptible to injury and mortality than those without them (Gaspin, 1975; Gaspin *et al*., 1976; Goertner *et al*., 1994). Barotrauma injuries have been documented during controlled exposure to impact pile driving (Halvorsen *et al.*, 2012b; Casper *et al.*, 2013).

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright, 1982). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation. The abundances of various fish (and invertebrates) near the detonation point for explosives could be altered for a few hours before animals from surrounding areas repopulate the area. However, these populations would likely be replenished as waters near the detonation point are mixed with adjacent waters. Repeated exposure of individual fish to sounds from underwater explosions is not likely and are expected to be short-term and localized. Long-term consequences for fish populations would not be expected.

UXO/MEC detonations would be dispersed in space and time; therefore, repeated exposure of individual fishes are unlikely. Mortality and injury effects to fishes from explosives would be localized around the area of a given in-water explosion, but only if individual fish and the explosive (and immediate pressure field) were co-located at the same time. Repeated exposure of individual fish to sound and energy from underwater explosions is not likely given fish movement patterns, especially schooling prey species. Most acoustic effects, if any, are expected to be short-term and localized. Long-term consequences for fish populations including key prey species within the project area would not be expected.

Required soft-starts would allow prey and marine mammals to move away from the pile-driving source prior to any noise levels that may physically injure prey and the use of the noise attenuation devices would reduce noise levels to the degree any mortality or injury of prey is also minimized. Use of bubble curtains, in addition to reducing impacts to marine mammals, for example, is a key mitigation measure in reducing injury and mortality of ESA-listed salmon on the West Coast. However, we recognize some mortality, physical injury and hearing impairment in marine mammal prey may occur, but we anticipate the amount of prey impacted in this manner is minimal compared to overall availability. Any behavioral responses to pile driving by marine mammal prey are expected to be brief. We expect that other impacts such as stress or masking would occur in fish that serve as marine mammals prey (Popper *et al.*, 2019); however, those impacts would be limited to the duration of impact pile driving and during any UXO/MEC detonations.

In addition to fish, prey sources such as marine invertebrates could potentially be impacted by noise stressors as a result of the proposed activities. Invertebrates appear to be able to detect sounds (Pumphrey, 1950; Frings and Frings, 1967) and are most sensitive to low-frequency sounds (Packard *et al*., 1990; Budelmann and Williamson, 1994; Lovell *et al*., 2005; Mooney *et al*., 2010). Data on response of invertebrates such as squid, another marine mammal prey species, to anthropogenic sound is more limited (de Soto, 2016; Sole *et al*., 2017b). Data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1-1.5 kHz, depending on the species, and so are likely to detect air gun noise (Kaifu *et al*., 2008; Hu *et al*., 2009; Mooney *et al*., 2010; Samson *et al*., 2014). Jones *et al*. (2020) found that when squid (*Doryteuthis pealeii*) were exposed to impulse pile-driving noise, body pattern changes, inking, jetting, and startle responses were observed and nearly all squid exhibited at least one response. However, these responses occurred primarily during the first eight impulses and diminished quickly, indicating potential rapid, short-term habituation. Auditory injuries (lesions occurring on the statocyst sensory hair cells) have been reported upon controlled exposure to low-frequency sounds, suggesting that cephalopods are particularly sensitive to low-frequency sound (Andre *et al*., 2011; Sole *et al*., 2013). Cumulatively for squid as a prey species, individual and population impacts from exposure to explosives, like fish, are not likely to be significant, and explosive impacts would be short-term and localized.

There is little information concerning potential impacts of noise on zooplankton populations. However, one recent study (McCauley *et al*., 2017) investigated zooplankton abundance, diversity, and mortality before and after exposure to air gun noise, finding that the exposure resulted in significant depletion for more than half the taxa present and that there were two to three times more dead zooplankton after air gun exposure compared with controls for all taxa. The majority of taxa present were copepods and cladocerans; for these taxa, the range within which effects on abundance were detected was up to approximately 1.2 km. In order to have significant impacts on r-selected species such as plankton, the spatial or temporal scale of impact must be large in comparison with the ecosystem concerned (McCauley *et al.*, 2017). Therefore, the large scale of effect observed here is of concern—particularly where repeated noise exposure is expected—and further study is warranted.

The presence of large numbers of turbines has been shown to impact meso- and sub-meso-scale water column circulation, which can affect the density, distribution, and energy content of zooplankton, and thereby their availability as marine mammal prey. The presence and operation of structures such as wind turbines are, in general, likely to result in local and broader oceanographic effects in the marine environment, and may disrupt marine mammal prey such as dense aggregations and distribution of zooplankton through altering the strength of tidal currents and associated fronts, changes in stratification, primary production, the degree of mixing, and stratification in the water column (Chen *et al*., 2021, Johnson *et al.,* 2021, Christiansen *et al.,* 2022, Dorrell *et al.,* 2022). However, the scale of impacts is difficult to predict and may vary from meters to hundreds of meters for local individual turbine impacts (Schultze *et al*., 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers (Christiansen *et al*., 2022).

Revolution Wind intends to install up to 79 turbines in 2024, which would become operational that same year. As described above, there is scientific uncertainty around the scale of oceanographic impacts (meters to kilometers) associated with turbine operation. Revolution Wind is located in a biologically productive area on an inshore temperate shelf sea on the inner portion of the southern New England continental shelf, an area of where the oceanography is dominated by complex interactions among wind-driven and tidal processes, and seasonal variations in solar heating. Shelf waters undergo a pronounced seasonal temperature cycle, influenced largely by air-sea interaction. Seasonality in salinity, associated mainly with spring freshening due to episodic coastal runoff, is less regular than that of temperature, and commonly weaker than inter-annual variability. Stratification, the vertical gradient in density associated with horizontal layering of water such that less dense layers overlie denser layers, results from comparably important influences of river freshening and surface heating. In Rhode Island Sound and the offshore project area during late fall and winter, stratification is minimal and circulation is a weak upwelling pattern directed offshore at shallow depths, and onshore near the seafloor. In spring and summer, strong stratification develops due to solar heating and a system of more distinct currents develops. Over most of the region, tidal currents are generally stronger than or comparable to seasonal mean flow patterns, as are weather-band current variations driven by the wind (Codiga and Ullman, 2010). Regional surface winds in winter average about 4-12 m/s (9-27 mi/hr) east-southeastward and, due to storms, are highly variable with peak speeds up to about 25 m/s (56 mi/hr). Summer winds are much less variable and weaker, averaging 2.5-7.5 m/s (6-17 mi/hr), oriented east-northeastward (Codiga and Ullman 2010). Fall and winter winds promote increased water column mixing, bringing nutrients into the water column for uptake by phytoplankton in Rhode Island Sound and the offshore project area during late fall and winter, stratification is minimal and circulation is a weak upwelling pattern directed offshore at shallow depths, and onshore near the seafloor. In spring and summer, strong stratification develops due to solar heating and a system of more distinct currents develops. Over most of the region, tidal currents are generally stronger than or comparable to seasonal mean flow patterns, as are weather-band current variations driven by the wind (Codiga and Ullman, 2010). Regional surface winds in winter average about 4-12 m/s (9-27 mi/hr) east-southeastward and, due to storms, are highly variable with peak speeds up to about 25 m/s (56 mi/hr). Summer winds are much less variable and weaker, averaging 2.5-7.5 m/s (6-17 mi/hr), oriented east-northeastward (Codiga and Ullman, 2010). Fall and winter winds promote increased water column mixing, bringing nutrients into the water column for uptake by phytoplankton. Seasonal stratification leads to pronounced spring and early fall blooms of phytoplankton and subsequently increased biological productivity of upper trophic level species (Codiga and Ullman, 2010).

In general, the scale of impacts to oceanographic features from offshore wind development is difficult to predict and may vary from hundreds of meters for local individual turbine impacts (Schultze *et al*., 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers when considering multiple wind farms (Christiansen *et al*., 2022). We anticipate any impacts to plankton aggregation, and hence availability as marine mammal prey, from turbine presence and operation as a result of oceanographic changes from the RWF (*i.e.*,79 turbines) would be limited (*e.g.*, Schultze *et al*., 2020). Overall, the combined impacts of sound exposure, explosions, and oceanographic impacts on marine mammal habitat resulting from the proposed activities would not be expected to have measurable effects on populations of marine mammal prey species. Prey species exposed to sound might move away from the sound source, experience TTS, experience masking of biologically relevant sounds, or show no obvious direct effects.

Acoustic Habitat

Acoustic habitat is the soundscape, which encompasses all of the sound present in a particular location and time, as a whole when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.*, produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of air gun arrays) or for Navy training and testing purposes (as in the use of sonar and explosives and other acoustic sources). Anthropogenic noise varies widely in its frequency, content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please also see the previous discussion on Masking), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). For more detail on these concepts see, *e.g.*, Barber *et al.*, 2009; Pijanowski *et al.*, 2011; Francis and Barber, 2013; Lillis *et al*., 2014.

The term “listening area” refers to the region of ocean over which sources of sound can be detected by an animal at the center of the space. Loss of communication space concerns the area over which a specific animal signal, used to communicate with conspecifics in biologically important contexts (*e.g.*, foraging, mating), can be heard, in noisier relative to quieter conditions (Clark *et al*., 2009). Lost listening area concerns the more generalized contraction of the range over which animals would be able to detect a variety of signals of biological importance, including eavesdropping on predators and prey (Barber *et al*., 2009). Such metrics do not, in and of themselves, document fitness consequences for the marine animals that live in chronically noisy environments. Long-term population-level consequences mediated through changes in the ultimate survival and reproductive success of individuals are difficult to study, and particularly so underwater. However, it is increasingly well documented that aquatic species rely on qualities of natural acoustic habitats, with researchers quantifying reduced detection of important ecological cues (*e.g.*, Francis and Barber, 2013; Slabbekoorn *et al*., 2010) as well as survivorship consequences in several species (*e.g.*, Simpson *et al*., 2014; Nedelec *et al*., 2015).

Sound produced from construction activities in the Revolution Wind project area may be widely dispersed or concentrated in small areas for varying periods. Any anthropogenic noise attributed to construction activities in the project area would be temporary, and the affected area would be expected to immediately return to the original state when these activities cease.

Water Quality

Indirect effects of explosives and unexploded ordnance to marine mammals via sediment are possible in the immediate vicinity of the ordnance. Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6-12 in (0.15-0.3 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3-6 ft (1-2 m) from the degrading ordnance (Rosen and Lotufo, 2010). Taken together, it is possible that marine mammals could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1-6 ft (0.3-2 m)).

Equipment types used by Revolution Wind within the project area, including ships and other marine vessels, potentially aircrafts, and other equipment, are also potential sources of by-products. All equipment would be properly maintained in accordance with applicable legal requirements. All such operating equipment would meet Federal water quality standards, where applicable.

Offshore Wind Farm Operational Noise

Although this proposed rulemaking primarily covers the noise produced from construction activities relevant to the Revolution Wind offshore wind facility, operational noise was a consideration in NMFS' analysis of the project, as all 79 turbines would become operational within the effective dates of the rule, beginning no sooner than Q2 2024. It is expected that all turbines would be operational by Q4 2024. Once operational, offshore wind turbines are known to produce continuous, non-impulsive underwater noise, primarily below 8 kHz.

In both newer, quieter, direct-drive systems (such as what has been proposed for Revolution Wind) and older generation, geared turbine designs, recent scientific studies indicate that operational noise from turbines is on the order of 110 to 125 dB re 1 µPa root-mean-square sound pressure level (SPL_{rms}) at an approximate distance of 50 m (Tougaard *et al.*, 2020). Tougaard *et al*. (2020) further noted that sound levels could reach as high as 128 dB re 1 µPa SPL_{rms} in the 10 Hz to 8 kHz range. However, the Tougaard *et al.* (2020) study assumed that the largest monopile-specific WTG was 3.6 MW, which is much smaller than those being considered for the Revolution Wind project. Tougaard further stated that the operational noise produced by WTGs is static in nature and lower than noise produced by passing ships. This is a noise source in this region to which marine mammals are likely already habituated. Furthermore, operational noise levels are likely lower than those ambient levels already present in active shipping lanes, such that operational noise would likely only be detected in very close proximity to the WTG (Thomsen *et al.*, 2006; Tougaard *et al*., 2020). In addition, Madsen *et al.* (2006) found the intensity of noise generated by operational wind turbines to be much less than the noise produced during construction, although this observation was based on a single turbine with a maximum power of 2 MW. Other studies by Jansen and de Jong (2016) and Tougaard *et al.* (2009) determined that, while marine mammals would be able to detect operational noise from offshore wind farms (again, based on older 2 MW models) for several thousand kilometers, they expected no significant impacts on individual survival, population viability, marine mammal distribution, or the behavior of the animals considered in their study (*i.e.*, harbor porpoises and harbor seals).

More recently, Stöber and Thomsen (2021) used monitoring data and modeling to estimate noise generated by more recently developed, larger (10 MW) direct-drive WTGs. Their findings, similar to Tougaard *et al.* (2020), demonstrated that modern turbine designs could generate higher operational noise levels (170 to 177 dB re 1 µPa

SPL_{rms} for a 10 MW WTG) than those previously reported for older models. However, the results in the study by Stöber and Thomsen (2021), have not been validated and were based on a small sample size. NMFS is requiring Revolution Wind to monitor noise generated by turbine operation to better understand noise levels from the advanced design turbines used in the Revolution Wind project (see **Proposed Monitoring and Reporting** section).

Operational noise was assessed in the DEIS BOEM developed for the Revolution Wind Project, within which BOEM states that operational noise would primarily consist of low-frequency sounds (60 to 300 Hz) and relatively low SPLs. While it is possible that some lower-frequency sounds produced by marine mammal species (*e.g.*¸ North Atlantic right whale upcalls (Parks *et al.,* 2009)) may fall within similar frequency ranges as operational wind turbine noise, this assessment was based on the older generation of turbines rather than more recent drive shafts. NMFS acknowledges that more research on WTG operational noise should be conducted to fill the current data gaps, including source level characterization and any potential influences on marine mammals and their prey. Revolution Wind did not request take and, based on the relatively small number of turbines and limited duration turbines would be operating within the proposed rule timeframe, NMFS is preliminarily not proposing to authorize take of marine mammals incidental to operational noise from WTGs. Therefore, the topic is not discussed or analyzed further herein.

Reef Effects

The presence of the RWF monopile foundations, scour protection, and cable protection would result in a conversion of the existing sandy bottom habitat to a hard bottom habitat with areas of vertical structural relief (Revolution Wind, 2022). This could potentially alter the existing habitat by creating an “artificial reef effect” that results in colonization by assemblages of both sessile and mobile animals within the new hard-bottom habitat (Wilhelmsson *et al*., 2006; Reubens *et al*., 2013; Bergström *et al*., 2014; Coates *et al*., 2014).

Artificial structures can create increased habitat heterogeneity important for species diversity and density (Langhamer, 2012). The WTG and OSS foundations would extend through the water column, which may serve to increase settlement of meroplankton or planktonic larvae on the structures in both the pelagic and benthic zones (Boehlert and Gill, 2010). Fish and invertebrate species are also likely to aggregate around the foundations and scour protection which could provide increased prey availability and structural habitat (Boehlert and Gill, 2010; Bonar *et al*., 2015).

The WTG foundations would have an estimated footprint of approximately 70 acres and the OSS foundations would have an estimated footprint of up to 1.4 acres (COP Table 3.3.4-2) (Revolution-Wind, 2022), providing up to 72 acres of heterogeneous habitat throughout the 20–35-year operational life of this Project. Numerous studies have documented significantly higher fish concentrations, including species like cod and pouting (*Trisopterus luscus*), flounder (*Platichthys flesus*), eelpout (*Zoarces viviparus*), and eel (*Anguila anguilla*), near the foundations than in surrounding soft bottom habitat (Langhamer and Wilhelmsson, 2009; Bergström *et al.*, 2013; Reubens *et al.*, 2013). In the German Bight portion of the North Sea, fish were most densely congregated near the anchorages of jacket foundations, and the structures extending through the water column were thought to make it more likely that juvenile or larval fish encounter and settle on them (Rhode Island Coastal Resources Management Council (RI-CRMC), 2010; Krone *et al.,* 2013). In addition, fish can take advantage of the shelter provided by these structures while also being exposed to stronger currents created by the structures, which generate increased feeding opportunities and decreased potential for predation (Wilhelmsson *et al.,* 2006). The presence of the foundations and resulting fish aggregations around the foundations is expected to be a long-term habitat impact, but the increase in prey availability could potentially be beneficial for some marine mammals.

The most likely impact to marine mammal habitat from the project is expected to be from impact and vibratory pile driving and UXO/MEC detonations, which may affect marine mammal food sources such as forage fish and could also affect acoustic habitat (see the *Auditory Masking* section) effects on marine mammal prey (*e.g.*, fish).

The most likely impact to fish from impact and vibratory pile driving activities at the project areas would be temporary behavioral avoidance of the area. The duration of fish avoidance of an area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be relatively minor and temporary due to the expected short daily duration of individual pile driving events and the relatively small areas being affected. The most likely impacts of prey fish from UXO/MEC detonations, if determined to be necessary, are injury or mortality if they are located within the vicinity when detonation occurs. However, given the likely spread of any UXOs/MECs in the project area, the low chance of detonation (as lift-and-shift and deflagration are the primary removal approaches), and that this area is not a biologically important foraging ground, overall effects should be minimal to marine mammal species. NMFS does not expect HRG acoustic sources to impact fish as most sources operate at frequencies likely outside the hearing range of the primary prey species in the project area. As described previously, the placement and operation of wind turbines can also impact hydrographic patterns, though these impacts assessed through this rule are expected to be minimal given the relatively small number of turbines that would be operational and the short amount of time covered under the rule.

These potential impacts on prey could influence the distribution of marine mammals within the project area, potentially necessitating additional energy expenditure to find and capture prey but, given the temporal and spatial scales anticipated for this project, not to the extent that would impact the reproduction or survival of any individual marine mammal. Although studies assessing the impacts of offshore wind development on marine mammals are limited, the repopulation of wind energy areas by harbor porpoises (Brandt *et al.*, 2016; Lindeboom *et al*., 2011) and harbor seals (Lindeboom *et al*., 2011; Russell *et al*., 2016) following the installation of wind turbines are promising.

Impacts to the immediate substrate during installation of piles are anticipated, but these would be limited to minor, temporary suspension of sediments, which could impact water quality and visibility for a short amount of time, but which would not be expected to have any effects on individual marine mammals.

Revolution Wind would be located within the migratory corridor BIA for North Atlantic right whales; however, the 68,450 acre (277 km^2) lease area occupies a fraction of the available habitat for North Atlantic right whales migrating through the region (66,591,935 acres; 269,488 km^2). In addition, although the project area overlaps with a fin whale feeding BIA (March through October), a significantly larger year-round fin whale feeding BIA is located in the southern Gulf of Maine, to the east and north of the project area.

Based on the information discussed herein, NMFS concludes that any impacts to marine mammal habitat are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations.

Estimated Take

This section provides an estimate of the number of incidental takes proposed for authorization through the regulations, which will inform both NMFS' consideration of "small numbers" and the negligible impact determination.

Authorized takes would primarily be by Level B harassment, as noise from impact and vibratory pile driving, HRG surveys, and UXO/MEC detonation(s) could result in behavioral disturbance or TTS. Impacts such as masking and TTS can contribute to behavior disturbances. There is also some potential for auditory injury (Level A harassment) of humpback whales, harbor porpoises, and gray and harbor seals (related to each species' hearing sensitivity) to result from impact pile driving and UXO/MEC detonations. For this action, this potential is limited to mysticetes, high-frequency cetaceans, and phocids due to their hearing sensitivities and the nature of the activities. As described below, the larger distances to the PTS thresholds, when considering marine mammal weighting functions, demonstrate this potential. For mid-frequency hearing sensitivities, when thresholds and weighting and the associated PTS zone sizes are considered, the potential for PTS from the noise produced by the project is negligible. The proposed mitigation and monitoring measures are expected to minimize the amount and severity of such taking to the extent practicable (see **Proposed Mitigation**).

As described previously, no serious injury or mortality is anticipated or proposed to be authorized for this activity. While, in general, mortality and serious injury of marine mammals could occur from UXO/MEC detonation if an animal is close enough to the source, the mitigation and monitoring measures included in the proposed rule would avoid this manner of take.

Below we describe how the proposed take numbers are estimated.

For acoustic impacts, generally speaking, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities.

In this case, as described below, there are multiple lines of data with which to address density or occurrence and, for each species and activity, the largest value resulting from the three take estimation methods described below (*i.e.,* density-based, PSO data-based, or mean group size) was carried forward as the amount of requested take, by Level B harassment. The amount of requested take, by Level A harassment, is based solely on density-based exposure estimates.

Below, we describe the acoustic thresholds NMFS uses, discuss the marine mammal density and occurrence information used, and then describe the modeling and methodologies applied to estimate take for each of Revolution Wind's proposed construction activities. NMFS has carefully considered all information and analysis presented by the applicant as well as all other applicable information and, based on the best available science, concurs that the applicant's estimates of the types and amounts of take for each species and stock are complete and accurate.

Marine Mammal Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment). Thresholds have also been developed to identify the pressure levels above which animals may incur different types of tissue damage (non-auditory injury or mortality) from exposure to pressure waves from explosive detonation. A summary of all NMFS' thresholds can be found at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance*.

Level B harassment – Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source or exposure context (*e.g.*, frequency, predictability, duty cycle, duration of the exposure, signal-to-noise ratio, distance to the source, ambient noise, and the receiving animals (hearing, motivation, experience, demography, behavior at time of exposure, life stage, depth) and can be difficult to predict (*e.g.*, Southall *et al.,* 2007, 2021; Ellison *et al.*, 2012). Based on what the available science indicates and the practical need to use a threshold based on a metric that is both predictable and measurable for most activities, NMFS typically uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS generally predicts that marine mammals are likely to be behaviorally harassed in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above the received root-mean-square sound pressure levels (RMS SPL) of 120 dB (referenced to 1 micropascal (re 1 μPa)) for continuous (*e.g.,* vibratory pile-driving, drilling) and above the received RMS SPL 160 dB re: 1 μPa for non-explosive impulsive (*e.g.*, seismic airguns) or intermittent (*e.g.*, scientific sonar) sources (Table 7). Generally speaking, Level B harassment take estimates based on these behavioral harassment thresholds are expected to include any likely takes by TTS as, in most cases, the likelihood of TTS occurs at distances from the source less than those at which behavioral harassment is likely. TTS of a sufficient degree can manifest as behavioral harassment, as reduced hearing sensitivity and the potential reduced opportunities to detect important signals (conspecific communication, predators, prey) may result in changes in behavior patterns that would not otherwise occur.

Table 7. Underwater Level B Harassment Acoustic Thresholds (NMFS, 2005)

Source type	Level B Harassment Threshold (RMS SPL)
Continuous	120 dB re 1 μPa
Non-explosive impulsive or intermittent	160 dB re 1 μPa

Revolution Wind’s construction activities include the use of continuous (*e.g.*, vibratory pile driving) and intermittent (*e.g.*, impact pile driving, HRG acoustic sources) sources, and, therefore, the 120 and 160 dB re 1 μPa (rms) thresholds are applicable.

Level A harassment - NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.*, metric resulting in the largest isopleth). Revolution Wind's proposed activities include the use of both impulsive and non-impulsive sources.

These thresholds are provided in Table 8 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance*.

Table 8. Onset of Permanent Threshold Shift (PTS) (NMFS 2018)

Hearing Group	PTS Onset Thresholds* (Received Level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{p,0\text{-pk,flat}}$: 219 dB $L_{E,p,\ LF,24h}$: 183 dB	*Cell 2* $L_{E,p,\ LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3* $L_{p,0\text{-pk,flat}}$: 230 dB $L_{E,p,\ MF,24h}$: 185 dB	*Cell 4* $L_{E,p,\ MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5* $L_{p,0\text{-pk,flat}}$: 202 dB $L_{E,p,HF,24h}$: 155 dB	*Cell 6* $L_{E,p,\ HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{p,0\text{-pk.flat}}$: 218 dB $L_{E,p,PW,24h}$: 185 dB	*Cell 8* $L_{E,p,PW,24h}$: 201 dB

* Dual metric thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration.

Note: Peak sound pressure level ($L_{p,0\text{-pk}}$) has a reference value of 1 μPa, and weighted cumulative sound exposure level ($L_{E,p}$) has a reference value of 1μPa^{2}s. In this Table, thresholds are

abbreviated to be more reflective of International Organization for Standardization standards (ISO, 2017). The subscript "flat" is being included to indicate peak sound pressure are flat weighted or unweighted within the generalized hearing range of marine mammals (*i.e.*, 7 Hz to 160 kHz). The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW pinnipeds) and that the recommended accumulation period is 24 hours. The weighted cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.*, varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these thresholds will be exceeded.

Explosive sources – Based on the best available science, NMFS uses the acoustic and pressure thresholds indicated in Tables 9 and 10 to predict the onset of behavioral harassment, TTS, PTS, tissue damage, and mortality.

Table 9. PTS onset, TTS onset, for underwater explosives (NMFS, 2018)

Hearing Group	PTS Impulsive Thresholds	TTS Impulsive Thresholds	Behavioral Threshold (multiple detonations)
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{pk,flat}$: 213 dB $L_{E,LF,24h}$: 168 dB	*Cell 3* $L_{E,LF,24h}$: 163 dB
Mid-Frequency (MF) Cetaceans	*Cell 4* $L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	*Cell 5* $L_{pk,flat}$: 224 dB $L_{E,MF,24h}$: 170 dB	*Cell 6* $L_{E,MF,24h}$: 165 dB
High-Frequency (HF) Cetaceans	*Cell 7* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 8* $L_{pk,flat}$: 196 dB $L_{E,HF,24h}$: 140 dB	*Cell 9* $L_{E,HF,24h}$: 135 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 10* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 11* $L_{pk,flat}$: 212 dB $L_{E,PW,24h}$: 170 dB	*Cell 12* $L_{E,PW,24h}$: 165 dB
* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS/TTS onset. Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa²s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI, 2013). However, ANSI defines peak sound pressure as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the overall marine mammal generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.*, varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.			

Additional thresholds for non-auditory injury to lung and gastrointestinal (GI) tracts from the blast shock wave and/or onset of high peak pressures are also relevant (at relatively close ranges) as UXO/MEC detonations, in general, have potential to result in mortality and non-auditory injury (Table 10). Lung injury criteria have been developed by the U.S. Navy (DoN (U.S. Department of the Navy) 2017a) and are based on the mass of the animal and the depth at which it is present in the water column due to blast pressure. This means that specific decibel levels for each hearing group are not provided and instead the criteria are presented as equations that allow for incorporation of specific mass and depth values. The GI tract injury threshold is based on peak pressure. The modified Goertner equations below represent the potential onset of lung injury and GI tract injury (Table 10).

Table 10. Lung and G.I. tract injury thresholds (DoN, 2017)

Hearing Group	Mortality (Severe lung injury)*	Slight Lung Injury*	G.I. Tract Injury
All Marine Mammals	*Cell 1* Modified Goertner model; Equation 1	*Cell 2* Modified Goertner model; Equation 2	*Cell 3* $L_{pk,flat}$: 237 dB

* Lung injury (severe and slight) thresholds are dependent on animal mass (Recommendation: Table C.9 from DoN (2017) based on adult and/or calf/pup mass by species).

Note: Peak sound pressure (L_{pk}) has a reference value of 1 μPa. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI, 2013). However, ANSI defines peak sound pressure as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the overall marine mammal generalized hearing range.

Modified Goertner Equations for severe and slight lung injury (pascal-second)

Equation 1: $103M^{1/3}(1 + D/10.1)^{1/6}$ Pa-s

Equation 2: $47.5M^{1/3}(1 + D/10.1)^{1/6}$ Pa-s

M animal (adult and/or calf/pup) mass (kg) (Table C.9 in DoN, 2017)
D animal depth (meters)

Below, we discuss the acoustic modeling, marine mammal density information, exposure estimate, and requested take methodologies for each of Revolution Wind's proposed construction activities. NMFS has carefully considered all information and analysis presented by the applicant as well as all other applicable information and, based on the best available science, concurs that the applicant's estimates of the types and amounts of take for each species and stock are complete and accurate.

Marine Mammal Density and Occurrence

In this section we provide the information about the presence, density, or group dynamics of marine mammals that will inform the take calculations. As noted above, depending on the species and activity type and as described in the take estimation section for each activity type, take estimates may be based on the Roberts *et al.* (2022) density estimates, marine mammal monitoring results from HRG surveys, or average group sizes.

Regarding habitat-based marine mammal density models for the project area, newer density models became available after Revolution Wind submitted their application (deemed Adequate & Complete on February 28, 2022) and Revolution Wind subsequently provided revised take estimates based on the updated density models, where appropriate. Specifically, in both the original application and the revised take estimates, the densities of marine mammals (individuals per unit area) expected to occur in the activity areas were calculated from habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory and the Marine-life Data and Analysis Team (*https://seamap.env.duke.edu/models/Duke/EC/*), which represent the best available science regarding marine mammal occurrence in the project area. Within the original version of the application (*https://www.fisheries.noaa.gov/national/marine-mammal-protection/apply-incidental-take-authorization*), different densities were used for the WTG and OSS foundation installation (Roberts *et al*., 2016, 2017, 2018, 2020); the export cable landfall (Roberts *et al*., 2016, 2017, 2018, 2021); the UXO/MEC detonations (Roberts *et al.*, 2016, 2017, 2018, 2021); and the site characterization surveys (Roberts *et al.*, 2016, 2017, 2018, 2021), during both the construction and operation phases.

On June 20, 2022, the Duke Marine Geospatial Ecology Laboratory released a new, and more comprehensive, set of marine mammal density models for the area along the East Coast of the United States (Roberts *et al.*, 2016; Roberts and Halpin, 2022). The differences between the new density data and the older data necessitated the use of updated marine mammal densities and, subsequently, revised marine mammal exposure and take estimates. Revolution Wind was able to use the same density dataset for all of its activities (Roberts *et al.*, 2016; Roberts and Halpin, 2022). Revolution Wind also incorporated updates to how the density data were selected from the model output for each activity, based on discussions with NMFS. For all activities, the width of the perimeter around the activity area used to select density data is now based on the largest exposure range (typically the Level B range) applicable to that activity and then rounded up to the nearest 5-km increment, (which reflects the spatial resolution of the Roberts and Halpin (2022) density models). For example, if the largest exposure range was 7.1 km, a 10-km perimeter around the activity area was created and used to select densities for all species from the Roberts and Halpin (2022) model output. All of this information was provided by Revolution Wind to NMFS as a memo (referred to as the Updated Density and Take Estimation Memo) on August 19, 2022, after continued discussion between Revolution Wind and NMFS, and NMFS has considered it in this analysis. The Updated Density and Take Estimation Memo was made public on NMFS' website on August 26, 2022 (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy*).

In adopting the information presented in the Updated Density and Take Estimation Memo, NMFS has ensured that the tables and figures reflect the latest marine mammal habitat-based density models released by Roberts and Halpin on June 20, 2022.

Immediately below, we describe observational data from monitoring reports and average group size information, both of which are appropriate to inform take estimates for certain activities or species in lieu of density estimates. As noted above, the density and occurrence information type resulting in the highest take estimate was used, and the explanation and results for each activity type are described in the specific activity sub-sections in the Modeling and Take Estimation section.

For some species, observational data from PSOs aboard HRG and geotechnical (GT) survey vessels indicate that the density-based exposure estimates may be insufficient to account for the number of individuals of a species that may be encountered during the planned activities. PSO data from HRG and GT surveys conducted in the area surrounding the Revolution Wind lease area and RWEC route from October 2018 through February 2021 (AIS-Inc., 2019; Bennett, 2021; Stevens *et al.*, 2021; Stevens and Mills, 2021) were analyzed to determine the average number of individuals of each species observed per vessel day. For each species, the total number of individuals observed (including the “proportion of unidentified individuals") was divided by the number of vessel days during which observations were conducted in 2018–2021 HRG surveys (470 vessel days) to calculate the number of individuals observed per vessel day, as shown in the final columns of Tables 7a and 7b in the Updated Density and Take Estimation Memo.

For other less-common species, the predicted densities from Roberts and Halpin (2022) are very low and the resulting density-based exposure estimate is less than a single animal or a typical group size for the species. In such cases, the mean group size was considered as an alternative to the density-based or PSO data-based take estimates to account for potential impacts on a group during an activity. Mean group sizes for each species were calculated from recent aerial and/or vessel-based surveys as shown in Table 11.

Table 11. Mean group sizes of species for which incidental take is being requested

Species	Individuals	Sightings	Mean Group Size	Source
Mysticetes				
Blue Whale*	3	3	1.0	Palka *et al*. (2017)

Fin Whale*	155	86	1.8	Kraus *et al.* (2016)
Humpback Whale	160	82	2.0	Kraus *et al.* (2016)
Minke Whale	103	83	1.2	Kraus *et al.* (2016)
North Atlantic Right Whale*	145	60	2.4	Kraus *et al.* (2016)
Sei Whale*	41	25	1.6	Kraus *et al.* (2016)
Odontocetes				
Atlantic Spotted Dolphin	1334	46	29.0	Palka *et al*. (2017)
Atlantic White-Sided Dolphin	223	8	27.9	Kraus *et al.* (2016)
Bottlenose Dolphin	259	33	7.8	Kraus *et al.* (2016)
Common Dolphin	2896	83	34.9	Kraus *et al*. (2016)
Harbor Porpoise	121	45	2.7	Kraus *et al*. (2016)
Pilot Whales	117	14	8.4	Kraus *et al.* (2016)
Risso's Dolphin	1215	224	5.4	Palka *et al.* (2017)
Sperm Whale*	208	138	1.5	Palka *et al.* (2017)
Pinnipeds				
Seals (Harbor and Gray)	201	144	1.4	Palka *et al*. (2017)

** Denotes species listed under the Endangered Species Act*

The estimated exposure and take tables for each activity present the density-based exposure estimates, PSO-date derived take estimate, and mean group size for each species. The amount of Level B harassment take requested is based on the largest of these three values, which is considered the maximum amount of take by Level B harassment that is reasonably likely to occur. As mentioned previously, the amount of take by Level A harassment requested is based strictly on density-based exposure modeling results.

Modeling and Take Estimation

Revolution Wind estimated potential density-based exposures in two separate ways, depending on the activity. For WTG and OSS monopile foundation installation, sophisticated sound and animal movement modeling was conducted to more accurately account for the movement and behavior of marine mammals and their exposure to the underwater sound fields produced during impact pile driving, as described below. For landfall construction activities, HRG surveys, and in-situ UXO/MEC disposal (*i.e.*, detonation), takes are estimated by multiplying the expected densities of marine mammals in the activity area(s) by the area of water likely to be ensonified above harassment threshold levels in a single day (24-hour period). The result is then multiplied by the number of days on which the activity is expected to occur, resulting in a density-based exposure estimate for each activity. Again, in some cases, these results directly inform the take estimates while, in other cases, adjustments are made based on monitoring results or average group size.

Below, we describe, in detail, the approach used to estimate take, in consideration of the acoustic thresholds and appropriate marine mammal density and occurrence information described above for each of the four different activities (WTG/OSS foundation installation, UXO/MEC detonation, landfall construction activities, and HRG surveys). The activity-specific exposure estimates (as relevant to the analysis) and activity-specific take estimates are also presented, alongside the combined totals annually, across the entire 5-year proposed project, and as the maximum take of marine mammals that could occur within any one year.

WTG and OSS Monopile Foundation Installation

Here, for WTG and OSS monopile foundation installation, we describe the models used to predict sound propagation and animal movement and the inputs to those models, the density and/or occurrence information used to support the take estimates for this activity type, and the resulting acoustic and exposure ranges, exposures, and takes proposed for authorization.

As indicated previously, Revolution Wind initially proposed to install up to 100 WTGs and 2 OSSs in the RWF (*i.e.*, a maximum of 102 foundations) but has recently informed NMFS that, due to installation feasibility issues, they would be removing 21 turbine locations from their project, reducing the total number of turbines from 100 to 79. Therefore, in this section, we present the acoustic and exposure for Revolution Wind's proposal of up to 79 WTF foundations and 2 OSS foundations.

The full installation parameters for each size monopile are described below. The two impact pile driving installation acoustic modeling scenarios are:

(1) 7/12-m diameter WTG monopile foundation: A total of 10,740 hammer strikes per pile modeled over 220 minutes (3.7 hours); and,

(2) 7/15-m diameter OSS foundation: A total of 11,564 hammer strikes per pile modeled over 380 minutes (6.3 hours).

Representative hammering schedules (Table 12), including increasing hammer energy with increasing penetration depth, were modeled because maximum sound levels usually occur during the last stage of impact pile driving, where the greatest resistance is typically encountered (Betke, 2008). The hammering schedule includes a soft start, or a period of hammering at a reduced hammer energy (relative to full operating capacity). Sediment types with greater resistance (*e.g.*, gravel versus sand) require hammers that deliver higher energy strikes and/or an increased number of strikes relative to installations in softer sediment. The project area includes a predominantly sandy bottom habitat, which is considered a softer sediment, based on HRG survey data collected in the lease area (see Appendices X1 and X2 of Revolution Wind's 2022 Construction and Operations Plan; Revolution Wind, 2022).

Table 12. Hammer Energy Schedules for Monopile Installation[1]

Monopile foundations (7/12-m diameter)			OSS Foundations (7/1- m diameter)		
Hammer: IHC S-4000			Hammer: IHC S-4000		
Energy Level (kilojoule, kJ)	Strike Count	Pile Penetration Depth (m)	Energy Level (kilojoule, kJ)	Strike Count	Pile Penetration Depth
1,000	1,705	0-6	1,000	954	0-5
2,000	3,590	6-24	2,000	2,944	5-17
3,000	2,384	24-36	3,000	4,899	17-36
4,000	3,061	36-50	4,000	2,766	36-50
Total:	10,740	50	Total:	11,563	50

1 - Modeled strike rate (min^{-1}) for both schedules = 50

Revolution Wind would install monopiles vertically to a penetration depth of 50 m; therefore, the model includes this assumption. While pile penetration depth among the foundation positions might vary slightly, this value was chosen as a reasonable penetration depth for the purposes of acoustic modeling based on Revolution Wind's engineering designs. All modeling was performed assuming that only one pile is driven at a time (as Revolution Wind would not conduct concurrent monopile installations), up to three WTG foundations would be installed per day, and no more than one OSS foundation would be installed per day.

Additional modeling assumptions based on Revolution Wind's engineering designs for monopile installation were as follows:

- Both WTG and OSS
  - Impact pile driver: IHC S-4000 (4000 kilojoules (kJ) rated energy; 1977 kilonewtons (kN) ram weight)
  - Helmet weight: 3234 kN.
- WTG only
  - Tapered 7/12-m steel cylindrical piling with 16-cm thick wall
  - Pile length: 110 m
- OSS only
  - Tapered 7/15-m cylindrical piling with 20-cm thick wall
  - Pile length: 120 m

Sound fields produced during monopile installation were estimated by first computing the force at the top of each pile associated with typical hammers using the GRLWEAP 2010 wave equation model (GRLWEAP, Pile Dynamics 2010), which produced forcing functions. The resulting forcing functions were used as inputs to JASCO Applied Sciences' (JASCO) Pile Driving Source Model (PDSM) to compute the monopile vibrations (*i.e.*, sounds) caused by hammer impact. To accurately calculate propagation metrics of an impulsive sound, a time-domain representation of the pressure wave in the water was used. To model the sound waves associated with the monopile vibration in an acoustic propagation model, the monopiles are represented as vertical arrays of discrete point sources. These discrete sources are distributed throughout the length of the monopile below the sea surface and into the sediment with vertical separation of 3 m. The length of the acoustic source is adjusted for the site-specific water depth and penetration at each energy level, and the section length of the monopile within the sediment is based on the monopile hammering schedule (Table 12). Pressure signatures for the point sources are computed from the particle velocity at the monopile wall up to a maximum frequency of 2,048 Hz. This frequency range is suitable because most of the sound energy generated by impact hammering of the monopiles is below 1 kHz. The results of this source level modeling were then incorporated into acoustic propagation models. The modeled source spectra are provided in Figures 10-14 of Appendix A of Revolution Wind's application (Kusel *et al*., 2021).

Underwater sound propagation (*i.e.*, transmission loss) at frequencies of 10 Hz to 2 kHz was predicted with JASCO's Marine Operations Noise Model (MONM) and full-wave Range-dependent Acoustic Model (RAM) parabolic equation (PE) model (FWRAM). MONM computes acoustic propagation via a wide-angle PE solution to the acoustic wave equation (Collins, 1993) based on a version of the U.S. Naval Research Laboratory's RAM, which has been modified to account for a solid seabed (Zhang and Tindle, 1995; Kusel *et al*., 2021). The PE method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins *et al*., 1996) and has been validated against experimental data in several underwater acoustic measurement programs by JASCO. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modeled area, underwater sound speed as a function of depth, and seabed type (a geoacoustic profile based on the overall stratified composition of the seafloor).

For impulsive sounds from impact pile driving, time-domain representations of the sounds generated in the water are required for calculating SPL and peak pressure level. Synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle PE algorithm as MONM. Unlike

MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modeled acoustic transfer function in closely spaced frequency bands (Kusel *et al*., 2021). FWRAM computes these synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, utilizing the same environmental inputs as MONM (bathymetry, water sound speed profile, and seabed geoacoustic profile). Because the monopile is represented as a linear array and FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman, 2012), using FWRAM ensures accurate characterization of vertical directivity effects in the near-field zone.

At frequencies less than 2 kHz, MONM computes acoustic propagation via a wide-angle PE solution to the acoustic wave equation based on a version of the U.S. Naval Research Laboratory's RAM modified to account for an elastic seabed. MONM-RAM incorporates bathymetry, underwater sound speed as a function of depth, and a geo-acoustic profile based on seafloor composition, and accounts for source horizontal directivity. The PE method has been extensively benchmarked and is widely employed in the underwater acoustics community, and MONM-RAM's predictions have been validated against experimental data in several underwater acoustic measurement programs conducted by JASCO. At frequencies greater than 2 kHz, MONM accounts for increased sound attenuation due to volume absorption at higher frequencies with the widely used BELLHOP Gaussian beam ray-trace propagation model. This modeling component incorporates bathymetry and underwater sound speed as a function of depth with a simplified representation of the sea bottom, as sub-bottom layers have a negligible influence on the propagation of acoustic waves with frequencies above 1 kHz. MONM-BELLHOP accounts for horizontal directivity of the source and vertical variation of the source beam pattern. Both propagation models account for full exposure from a direct acoustic wave, as well as exposure from acoustic wave reflections and refractions (*i.e.*, multi-path arrivals at the receiver).

Two WTG and three OSS locations within the RWF were selected for acoustic modeling to provide representative propagation conditions and sound fields (see Figure 2 in Kusel *et al.*, 2021). The two WTG locations were selected to represent the relatively shallow (36.8 m) northwest section of the RWF to the somewhat deeper (41.3 m) southeast section. The three potential OSS locations (of which only two would be used to install the two OSS foundations) selected occupy similar water depths (33.7, 34.2, and 34.4 m). The acoustic propagation fields applied to exposure modeling (described below) were those conservatively based on the WTG (1 of 2) and OSS (1 of 3) locations resulting in the largest fields. In addition to bathymetric and seabed geoacoustic data specific to the specific locations within the RWF, acoustic propagation modeling was conducted separately for “summer” (April through November) and “winter” (December through March) using representative sound velocity profiles for those timeframes (based on in situ measurements of temperature, salinity, and pressure within the water column) to account for variations in the acoustic propagation conditions between summer and winter.

The estimated pile driving schedules (Table 12) were used to calculate the SEL sound fields at different points in time during both WTG and OSS monopile foundation installation. Models are more efficient at estimating SEL than SPL_{rms}. Therefore, conversions may sometimes be necessary to derive the corresponding SPL_{rms}. Acoustic propagation was modeled for a subset of sites using the FWRAM, from which broadband SEL to SPL conversion factors were calculated. The FWRAM required intensive calculation for each site, thus a representative subset of modeling sites was used to develop azimuth-, range-, and depth-dependent conversion factors (Kusel *et al.*, 2021).

These conversion factors were used to calculate the broadband SPL_{rms} from the broadband SEL prediction.

Revolution Wind modeled both acoustic ranges and exposure ranges. Acoustic ranges represent the distance to a harassment threshold based on sound propagation through the environment (*i.e.*, independent of any receiver) while exposure range represents the distance at which an animal can accumulate enough energy to exceed a Level A harassment threshold in consideration of how it moves through the environment (*i.e.*, using movement modeling). In both cases, the sound level estimates are calculated from three-dimensional sound fields and then, at each horizontal sampling range, the maximum received level that occurs within the water column is used as the received level at that range. These maximum-over-depth (R_{max}) values are then compared to predetermined threshold levels to determine exposure and acoustic ranges to Level A harassment and Level B harassment isopleths. However, the ranges to a threshold typically differ among radii from a source, and also might not be continuous along a radii because sound levels may drop below threshold at some ranges and then exceed threshold at farther ranges. To minimize the influence of these inconsistencies, 5 percent of the farthest such footprints were excluded from the model data. The resulting range, $R_{95\%}$, was chosen to identify the area over which marine mammals may be exposed above a given threshold, because, regardless of the shape of the maximum-over-depth footprint, the predicted range encompasses at least 95 percent of the horizontal area that would be exposed to sound at or above the specified threshold. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the heterogeneity of the acoustic environment. $R_{95\%}$ excludes ends of protruding areas or small isolated acoustic foci not representative of the nominal ensonified zone. For purposes of calculating take by Level A harassment and Level B harassment, Revolution Wind applied $R_{95\%}$ exposure ranges (described below), not acoustic ranges, to estimate take and determine mitigation distances for the reasons described below.

In order to best apply the (SEL_{cum}) harassment thresholds for PTS, it is necessary to consider animal movement, as the results are based on how sound moves through the environment between the source and the receiver. Applying animal movement and behavior within the modeled noise fields provides the exposure range, which allows for a more realistic indication of the distances at which PTS acoustic thresholds are reached that considers the accumulation of sound over different durations (note that in all cases the distance to the peak threshold is less than the SEL-based threshold).

As described in Section 2.6 of Appendix A of Revolution Wind's ITA application, for modeled animals that have received enough acoustic energy to exceed a given Level A harassment threshold, the exposure range for each animal is defined as the closest point of approach (CPA) to the source made by that animal while it moved throughout the modeled sound field, accumulating received acoustic energy. The resulting exposure range for each species is the 95th percentile of the CPA distances for all animals that exceeded threshold levels for that species (termed the 95 percent exposure range ($ER_{95\%}$)). The $ER_{95\%}$ ranges are species-specific rather than categorized only by functional hearing group, which allows for the incorporation of more species-specific biological parameters (*e.g.*, dive durations, swim speeds, *etc.*) for assessing the impact ranges in the model. Furthermore, because these $ER_{95\%}$ ranges are species-specific, they can be used to develop mitigation monitoring or shutdown zones.

Sound exposure modeling, like JASCO's Animal Simulation Model Including Noise Exposure (JASMINE), involves the use of a three-dimensional computer simulation in which simulated animals (animats) move through the modeled marine environment over time in ways that are defined by the known or assumed movement patterns for each species derived from visual observation, animal borne tag, or other similar studies. The predicted 3D sound fields (*i.e.*, the output of the acoustic modeling process described earlier) are sampled by animats using movement rules derived from animal observations. The output of the simulation is the exposure history for each animat within the simulation. The precise location of animats (and their pathways) are not known prior to a project, therefore, a repeated random sampling technique (Monte Carlo) is used to estimate exposure probability with many animats and randomized starting positions. The probability of an animat starting out in or transitioning into a given behavioral state can be defined in terms of the animat's current behavioral state, depth, and the time of day. In addition, each travel parameter and behavioral state has a termination function that governs how long the parameter value or overall behavioral state persists in the simulation.

The sound field produced by the activity, in this case impact pile driving, is then added to the modeling environment at the location and for the duration of time anticipated for one or more pile installations. At each time step in the simulation, each animat records the received sound levels at its location resulting in a sound exposure history for each animat. These exposure histories are then analyzed to determine whether and how many animats (*i.e.*, simulated animals) were exposed above harassment threshold levels. Finally, the density of animats used in the modeling environment, which is usually much higher than the actual density of marine mammals in the activity area so that the results are more statistically robust, is compared to the actual density of marine mammals anticipated to be in the project area.

The output of the simulation is the exposure history for each animat within the simulation, and the combined history of all animats gives a probability density function of exposure during the project. Scaling the probability density function by the real-world densities for an animal results in the mean number of animats expected to be exposed over the duration of the project. Due to the probabilistic nature of the process, fractions of animats may be predicted to exceed threshold. If, for example, 0.1 animats are predicted to exceed threshold in the model, that is interpreted as a 10-percent chance that one animat will exceed a relevant threshold during the project, or equivalently, if the simulation were re-run ten times, one of the ten simulations would result in an animat exceeding the threshold. Similarly, a mean number prediction of 33.11 animats can be interpreted as re-running the simulation where the number of animats exceeding the threshold may differ in each simulation but the mean number of animats over all of the simulations is 33.11. A portion of an individual marine mammal cannot be taken during a project, so it is common practice to round mean number animat exposure values to integers using standard rounding methods. However, for low-probability events it is more precise to provide the actual values. For this reason, mean number values are not rounded. A more detailed description of this method is available in Appendix A of Revolution Wind's application.

For Revolution Wind's proposed project, JASMINE animal movement model was used to predict both the $ER_{95\%}$ ranges and the probability of marine mammal exposure to impact pile driving sound generated by monopile installation. Sound fields generated by the acoustic propagation modeling described above were input into the JASMINE model, and animats were programmed based on the best available information to "behave" in ways that reflect the behaviors of the 16 marine mammal species expected to occur in the project area. The various parameters for forecasting realistic marine mammal behaviors (*e.g.*, diving, foraging, surface times, etc.) are determined based on the available literature (*e.g.*, tagging studies). When literature on these behaviors was not available for a particular species, it was extrapolated from a similar species for which behaviors would be expected to be similar to the species of interest. The parameters used in JASMINE describe animat movement in both the vertical and horizontal planes (*e.g.*, direction, travel rate, ascent and descent rates, depth, bottom following, reversals, inter-dive surface interval). More information regarding modeling parameters can be found Appendix A of the ITA application.

The mean numbers of animats that may be exposed to noise exceeding acoustic thresholds were calculated based on installation of 1, 2, or 3 WTG foundations and, separately, 1 or 2 OSS foundations in 24 hours. Animats were modeled to move throughout the three-dimensional sound fields produced by each construction schedule for the entire construction period. For PTS exposures, both SPL_{peak} and SPL_{cum} were calculated for each species based on the corresponding acoustic criteria. Once an animat is taken within a 24-hour period, the model does not allow it to be taken a second time in that same period but rather resets the 24-hour period on a sliding scale across 7 days of exposure. For Level A harassment, an individual animat's exposure levels are summed over that 24-hour period to determine its total received energy, and then compared to the appropriate PTS threshold. Takes by behavioral disturbance are predicted when an animat is modeled to come within the area ensonified by sound levels exceeding the corresponding Level B harassment thresholds. Please note that animal aversion was not incorporated into the JASMINE model runs that were the basis for the take estimate for any species. See Appendix A of the ITA application for more details on the JASMINE modeling methodology.

Revolution Wind would employ a noise abatement system during all impact pile driving of monopiles. Noise abatement systems, such as bubble curtains, are sometimes used to decrease the sound levels radiated from a source. In modeling the sound fields produced by Revolution Wind's proposed activities, hypothetical broadband attenuation levels of 0 dB, 6 dB, 10 dB, 12 dB, 15 dB, and 20 dB for were modeled to gauge effects on the ranges to thresholds given these levels of attenuation. Although six attenuation levels were evaluated, Revolution Wind anticipates that the noise abatement system ultimately chosen will be capable of reliably reducing source levels by 10 dB; therefore, modeling results assuming 10-dB attenuation are carried forward in this analysis. Recently reported in situ measurements during installation of large monopiles (approximately 8 m) for more than 150 WTGs in comparable water depths (greater than 25 m) and conditions in Europe indicate that attenuation levels of 10 dB are readily achieved (Bellmann, 2019; Bellmann *et al.*, 2020) using single big bubble curtains (BBCs) as a noise abatement system. Designed to gather additional data regarding the efficacy of BBCs, the Coastal Virginia Offshore Wind (CVOW) pilot project systematically measured noise levels resulting from the impact driven installation of two 7.8 m monopiles, one with a noise abatement system (double bubble curtain (dBBC)) and one without (CVOW, unpublished data). Although many factors contributed to variability in received levels throughout the installation of the piles (*e.g.*, hammer energy, technical challenges during operation of the dBBC), reduction in broadband SEL using the dBBC (comparing measurements derived from the mitigated and the unmitigated monopiles) ranged from approximately 9 to 15 dB. The effectiveness of the dBBC as a noise abatement measure was found to be frequency dependent, reaching a maximum around 1 kHz; this finding is consistent with other studies (*e.g.*, Bellman, 2014; Bellman *et al.*, 2020). The noise measurements were incorporated into a dampened cylindrical transmission loss model to estimate distances to Level A harassment and Level B harassment isopleths. The estimated distances for the monopile with the dBBC were more than 90 percent (Level A) and 74 percent (Level B) smaller than those estimated for the unmitigated pile (CVOW). Modeling results assuming different amounts of attenuation can be found in Appendix A of Revolution Wind’s ITA application. Additional information related to Revolution Wind’s proposed use of noise abatement systems is provided in the **Proposed Mitigation**, and **Proposed Monitoring and Reporting** sections.

As described more generally above, updated Roberts *et al*. (2022) habitat-based marine mammal density models provided the densities used to inform and scale the marine mammal exposure estimates produced by the JASMINE model. For monopile installation, specifically, mean monthly densities for all species were calculated by first selecting density data from 5 x 5 km (3.1 x 3.1 mile) grid cells (Roberts *et al.*, 2016; Roberts and Halpin, 2022) both within the lease area and out to 10 km (6.2 mi) from the perimeter of the lease area. This is a reduction from the 50 km (31 mi) perimeter used in the ITR application. The relatively large area selected for density estimation encompasses and extends approximately to the largest estimated exposure acoustic range ($ER_{95\%)}$ to the isopleth corresponding to Level B harassment, assuming no noise attenuation) (see Tables 19 and 20 of the ITA application) for all hearing groups using the unweighted threshold of 160 dB re 1 μPa (rms). Please see Figure 6 in Revolution Wind's Updated Density and Take Estimation Memo for an example of a density map showing Roberts and Halpin (2022) density grid cells overlaid on a map of the RWF.

Although there is some uncertainty in the monopile foundation installation schedule, Revolution Wind anticipates that it would occur over approximately one month provided good weather conditions and no unexpected delays. The exposure calculations were thus conducted using marine mammal densities from the month with the highest average density estimate for each species, based on the assumption that all 79 WTG and two OSS foundations would be installed in the highest density month (78 WTG monopile (3 per day for 26 days), 1 WTG monopile (1 per day for 1 day) and 2 OSS monopile foundations (1 per day for 2 days)). Due to differences in the seasonal migration and occurrence patterns, the month selected differs for each species. The estimated monthly density of seals provided in Roberts and Halpin (2022) includes all seal species present in the region as a single guild. To split the resulting "seal" density-based exposure estimate by species (harbor and gray seals), the estimate was multiplied by the proportion of the combined abundance attributable to each species. Specifically, the SAR N_{best} abundance estimates (Hayes *et al.*, 2021) for the two species (gray seal = 27,300, harbor seal = 61,336; total = 88,636) were summed and divided the total by the estimate for each species to get the proportion of the total for each species (gray seal = 0.308; harbor seal = 0.692). The total estimated exposures value based on the pooled seal density provided by Roberts and Halpin (2022) was then multiplied by these proportions to get the species-specific exposure estimates. Monthly densities were unavailable for pilot whales, so the annual mean density was used instead. The blue whale density was considered too low to be carried into exposure estimation so the amount of blue whale take Revolution Wind requested (see **Estimated Take**) is instead based on group size. Table 13 shows the maximum average monthly densities by species that were incorporated in exposure modeling to obtain conservative exposure estimates.

Table 13. Maximum Average Monthly Marine Mammal Densities (Animals Per Km²) Within and Around the Lease Area Out To 10 Km (6.2 Mi)

Marine Mammal Species	Monopile Foundations
	Highest Density
Blue whale [1,2]	–
Fin whale [1]	0.0029 (July)
Humpback whale	0.0021 (May)
Minke whale	0.0174 (May)
North Atlantic right whale [1]	0.0026 (December)
Sei whale [1]	0.0013 (May)

Atlantic spotted dolphin	0.0005 (October)
Atlantic white-sided dolphin	0.0174 (May)
Bottlenose dolphin	0.0091 (August)
Common dolphin	0.0743 (December)
Harbor porpoise	0.0515 (December)
Pilot whales[3]	0.0007 (annual)
Risso's dolphin	0.0017 (December)
Sperm whale[1]	0.0004 (August)
Seals (Harbor and Gray)	0.2225 (May)

1 – Listed as Endangered under the Endangered Species Act.
2 – Exposure modeling for the blue whale was not conducted because impacts to those species approach zero due to their low predicted densities in the Project; therefore, were excluded from all quantitative analyses and tables based on modeling results.
3 – Roberts and Halpin (2022) does not distinguish between short- and long-finned pilot whales, thus the pooled density provided represents both species.

For the exposure analysis, it was assumed that a maximum of three WTG monopile foundations may be driven in 24 hours, presuming installations are permitted to continue in darkness. It is unlikely that this installation rate would be consistently possible throughout the RWF construction phase, but this scenario was considered to have the greatest potential impact on marine mammals and was, therefore, carried forward into take estimation. Exposure ranges ($ER_{95\%}$) to the Level A SEL_{cum} thresholds and Level B SPL_{rms} threshold resulting from animal exposure modeling for installation of one (for comparative purposes) or three (assumed for exposure modeling) WTG foundations and one OSS foundation per day (assumed for exposure modeling), assuming 10-dB of attenuation, for the summer (when Revolution Wind intends to install the majority of monopile foundations) and winter are shown in Tables 14 and 15. Any activities conducted in the winter (December) would utilize monitoring and mitigation measures based on the exposure ranges ($ER_{95\%}$) calculated using winter sound speed profiles. Revolution Wind does not plan to install two OSS foundations in a single day, therefore, modeling results are provided for installation of a single OSS foundation per day. Exposure ranges were also modeled assuming installation of two WTG foundations per day (not shown here); see Appendix A of Revolution Wind's ITA application for those results. Meaningful differences (greater than 500 m) between species within the same hearing group occurred for low-frequency cetaceans, so exposure ranges are shown separately for those species (Tables 14 and 15). For mid-frequency cetaceans and pinnipeds, the largest value among the species in the hearing group was selected to be included in Tables 14 and 15.

Table 14. Exposure Ranges[1] ($ER_{95\%}$) To Level A (SEL_{cum}) Thresholds For Installation Of One and Three 7/12-m WTG Monopiles (10,740 Strikes) Or One 7/15-m OSS Monopile (11,564 Strikes) During Summer and Winter Assuming 10-dB Attenuation

		Range (km)					
Hearing Group	SEL_{cum} Threshold (dB re 1 μPa²·s)	WTG Monopile 1 pile/day		WTG Monopile 3 piles/day		OSS Monopile 1 pile/day	
		Summer	Winter	Summer	Winter	Summer	Winter
Low-frequency	183						
Fin Whale*	-	2.15	3.53	2.23	4.38	1.57	2.68
Humpback Whale	-	2.46	4.88	2.66	6.29	1.79	3.56
Minke Whale	-	1.32	3.03	1.51	3.45	0.94	1.81
North Atlantic Right Whale*	-	1.85	3.42	1.93	3.97	1.25	2.66
Sei Whale*	-	1.42	2.82	1.81	3.67	1.22	2.05
Mid-frequency	185	0	0.01	0.02	0.02	0	0
High-frequency	155	1.28	2.29	1.34	2.33	0.83	1.25
Phocid pinnipeds	185	0.6	0.73	0.44	0.81	0.37	0.37

** Denotes species listed under the Endangered Species Act*
1 - Exposure ranges are a result of animal movement modeling.

Table 15. Exposure Ranges[1] ($ER_{95\%}$) To The Level B (SPL_{rms}) Isopleth For Installation Of One and Three 7/12-m WTG Monopiles Or One 7/15-m OSS Monopile During Summer and Winter Assuming 10-dB Attenuation

Range (km)						
Hearing Group	WTG Monopile 1 pile/day		WTG Monopile 3 piles/day		OSS Monopile 1 pile/day	
	Summer	Winter	Summer	Winter	Summer	Winter
Fin Whale*	3.72	4.05	3.76	4.09	3.62	3.88
Humpback Whale	3.75	4.15	3.72	4.11	3.61	3.87
Minke Whale	3.71	4.07	3.63	4.07	3.56	3.84
North Atlantic Right Whale*	3.70	4.06	3.67	3.95	3.51	3.75
Sei Whale*	3.66	4.11	3.67	4.02	3.58	3.92
Mid-frequency	3.69	4.07	3.67	4.03	3.63	3.81
High-frequency	3.71	4.00	3.62	4.03	3.50	3.91
Phocid pinnipeds	3.79	4.21	3.80	4.23	3.75	4.02

** Listed as Endangered under the Endangered Species Act.*
1 - Exposure ranges are a result of animal movement modeling.

As mentioned previously, acoustic ranges ($R_{95\%}$) were also modeled. These distances were not applied to exposure estimation, but were used to define the Level B harassment zones for all species (see **Proposed Mitigation**) for WTG and OSS foundation installation in summer and winter (in parentheses):

- WTG monopile: 3,833 m (4,271 m)
- OSS monopile: 4,100 m (4, 698 m)

Finally, the results of marine mammal exposure modeling, assuming 10-dB attenuation, for installation of 79 WTG and 2 OSS monopile foundations are shown in columns 2 and 3 of Table 16; these values assume that all 81 foundations (79 WTGs and 2 OSSs) would be installed in a single year, and form the basis for the amount of take incidental to construction of the RWF requested by Revolution Wind and proposed for authorization by NMFS. Columns 4 and 5 show what the take estimates would be if the PSO data or average group size, respectively, were used to inform the take by Level B harassment in lieu of the density and exposure modeling. The last column represents the take that NMFS is proposing for authorization, which is based on the highest of the three estimates shown in columns 3, 4, and 5. The Level A exposure estimates shown in Table 16 are based only on the Level A SEL_{cum} threshold and associated exposure ranges (Table 14), as the very short distances to isopleths based on the Level A SPL_{pk} thresholds (Table 14 in the ITA application) resulted in no meaningful likelihood of take from exposure to those sound levels. The Level B exposure estimates shown in Table 16 are based on the exposure ranges resulting from sound exposure modeling using the unweighted 160 dB SPL_{rms} criterion (Table 15).

Table 16. Estimated Take, By Level A Harassment and Level B Harassment, For 79 (7/12-m) WTG and Two (7/15-m) OSS Monopile Foundation Installations Assuming 10-dB Attenuation

Species	Exposure Modeling Take Estimates[1]		PSO Data Take Estimate	Mean Group Size	Maximum Annual Level B Take
	Level A (SPL_{cum})	Level B (SPL_{rms})			
Blue Whale*	N/A	N/A	-	1.0	1
Fin Whale*	6.4	14.9	15.8	1.8	16
Humpback Whale	6.5	11.5	47.1	2.0	48
Minke Whale	60.9	191.2	5.8	1.2	192
North Atlantic Right Whale*	17.5	21.6	1.4	2.4	22
Sei Whale*	2.5	7.8	0.4	1.6	8
Atlantic Spotted Dolphin	0.0	0.0	-	29.0	29
Atlantic White-Sided Dolphin	0.1	199.5	4.6	27.9	200
	0.0	68.8	51.4	7.8	69

Bottlenose Dolphin					
Common Dolphin	0.0	1,327.6	1,308.9	34.9	1,328
Harbor Porpoise	320.9	661.0	1.3	2.7	661
Pilot Whales	0.0	5.5	-	8.4	9
Risso’s Dolphin	0.0	15.5	3.6	5.4	16
Sperm Whale*	0.0	2.8	-	1.5	3
Gray Seal	4.9	253.8	3.5	1.4	311
Harbor Seal	32.0	894.8	4.6	1.4	895

** Denotes species listed under the Endangered Species Act*
1 - Exposure estimates assume all piles will be installed in a single year.

Potential UXO/MEC detonations

To assess the impacts from UXO/MEC detonations, JASCO conducted acoustic modeling based on previous underwater acoustic assessment work that was performed jointly between NMFS and the United States Navy. JASCO modeled the acoustic ranges generated by UXO/MEC detonations, including three sound pressure metrics (peak pressure level, sound exposure level, and acoustic impulse) to the thresholds presented previously in Tables 9 and 10. Charge weights of 2.3 kgs, 9.1 kgs, 45.5 kgs, 227 kgs, and 454 kgs, which is the largest charge the Navy considers for the purposes of its analyses (see the **Description of the Specified Activities** section), were modeled to determine the ranges to mortality, gastrointestinal injury, lung injury, PTS, and TTS thresholds. First, the source pressure function used for estimating peak pressure level and impulse metrics was calculated with an empirical model that approximates the rapid conversion of solid explosive to gaseous form in a small bubble under high pressure, followed by exponential pressure decay as that bubble expands (Hannay and Zykov, 2022). This initial empirical model is only valid close to the source (within tens of meters), so alternative formulas were used beyond those distances to a point where the sound pressure decay with range transitions to the spherical spreading model. The SEL and SPL thresholds for injury and behavioral disturbance occur at distances of many water depths in the relatively shallow waters of the project (Hannay and Zykov, 2022). As a result, the sound field becomes increasingly influenced by the contributions of sound energy reflected from the sea surface and sea bottom multiples times. To account for this, propagation modeling was carried out in decidecade frequency bands using JASCO’s MONM, as described in the WTG and OSS Foundation Installation section above. This model applies a parabolic equation approach for frequencies below 4 kHz and a Gaussian beam ray trace model at higher frequencies (Hannay and Zykov, 2022). In the Revolution Wind project’s location, sound speed profiles generally change little with depth, so these environments do not have strong seasonal dependence. The propagation modeling was performed using an average sound speed profile for summer, which is representative of the most likely time of year (May through November) UXO/MEC detonation activities would occur, if necessary. Please see Appendix B of Revolution Wind’s application for more technical details about the modeling methods, assumptions and environmental parameters used as inputs (Hannay and Zykov, 2022).

The type and net explosive weight of UXO/MECs that may be detonated are not known at this time. To capture a range of potential UXO/MECs, five categories or “bins” of net explosive weight established by the U.S. Navy (2017a) were selected for acoustic modeling (Table 17). These charge weights were modeled at four different locations off Rhode Island, consisting of different depths (12 m (Site S1), 20 m (Site S2), 30 m (Site S3), and 45 m (Site S4)). The sites were deemed to be representative of both the export cable route and the lease area. Two are located along the RWEC corridor (Sites S1 and S2) and two are located inside the RWF (Sites S3 and S4). The locations for these modeling sites are shown in Figure 1 of Appendix B in Revolution Wind’s application.

- Shallow water export cable route (ECR): Site S1; In the channel within Narragansett Bay (12 m depth);
- Shallow water ECR: Site S2; Intermediate waters outside of Narragansett Bay (20 m depth);
- Shallow water lease area: Site S3; Shallower waters in the southern portion of the Hazard Zone 2 area (30 m depth);
- Deeper water lease area: Site S4; Deeper waters in northern portion of the Hazard Zone 2 area (45 m depth).

Table 17. Navy "Bins" and Corresponding Maximum Charge Weights (Equivalent TNT) Modeled

Navy Bin Designation	Maximum Equivalent (kg)	Weight (TNT) lbs
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227	500
E12	454	1000

Below, in Table 18, we present distances to PTS and TTS thresholds for only the 454 kg UXO/MEC, as this has the greatest potential for these impacts and is what is used to estimate take. NMFS notes that it is extremely unlikely that all UXO/MECs for which Revolution Wind deems detonation necessary would consist of this 454 kg charge weight. However, it is not currently known how easily Revolution Wind would be able to identify the size and charge weights of UXOs/MECs in the field. Therefore, for this action, NMFS has proposed to require Revolution Wind to implement mitigation measures assuming the largest E12 charge weight as a conservative approach. We do note that if Revolution Wind is able to reliably demonstrate that they can easily and accurately identify charge weights in the field, NMFS will consider mitigation and monitoring zones based on UXO/MEC charge weight for the final rulemaking rather than assuming the largest charge weight in every situation.

To further reduce impacts to marine mammals, Revolution Wind would additionally deploy a noise abatement system during detonation events, similar to that described for monopile installation, and expects that this system would be able to achieve 10-dB attenuation. This expectation is based on an assessment of UXO/MEC clearance activities in European waters, as summarized by Bellman and Betke (2021).

Due to the implementation of mitigation and monitoring measures, the potential for mortality and non-auditory injury is low and Revolution Wind did not request, and we are not proposing to authorize, take by mortality or non-auditory injury. For this reason we are not presenting all modeling results here; however, they can be found in Appendix B of the ITA application.

For the RWEC, the largest distances to the PTS (Table 18) and TTS (Table 20) SEL thresholds were selected among the modeling results for Sites S1 and S2. The distances were not always consistently larger for one site versus the other, so the results in Tables 18 and 20 represent a mixture of the two sites. This same approach was used to determine the largest distances to these thresholds for the lease area (Tables 19 and 21). For all species, the distance to the SEL thresholds exceeded that for the peak thresholds (Table 29 in Appendix B of the ITA application). Model results for all sites and all charge weights can be found in Appendix B of Revolution Wind's application. Further, Revolution Wind presented the results for both mitigated and unmitigated scenarios in the ITA application and the August 2022 Updated Densities and Takes Estimation Memo. Since that time, Revolution Wind has committed to the use of a noise abatement system during all detonations, and plans to achieve a 10-dB noise reduction as minimum. As a result, the Updated Densities and Take Estimation Memo mitigated UXO/MEC scenario is the one carried forward here. Therefore, only the attenuated results are presented in

Tables 18-21 and were carried forward into the exposure and take estimation. Additional information can be found in JASCO's UXO/MEC report and the Revised Density and Take Estimate Memo on NMFS' website (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy*).

NMFS notes that the more detailed results for the mortality and non-auditory injury analysis for marine mammals for onset gastrointestinal injury, onset lung injury, and onset of mortality can be found in Appendix B of the ITA application, which can be found on NMFS' website. NMFS preliminarily concurs with Revolution Wind's analysis and does not expect or propose to authorize any non-auditory injury, serious injury, or mortality of marine mammals from UXO/MEC detonation. The modeled distances to the mortality threshold for all UXO/MECs sizes for all animal masses are small (*i.e.*, 5-353 m; see Tables 35-38 in Appendix B of Revolution Wind's application), as compared to the distance/area that can be effectively monitored. The modeled distances to non-auditory injury thresholds range from 5 to 648 m (see Tables 30-34 in Appendix B of the application). Revolution Wind would be required to conduct extensive monitoring using both PSOs and PAM operators and clear an area of marine mammals prior to detonating any UXO. Given that Revolution Wind would be employing multiple platforms to visually monitor marine mammals as well as passive acoustic monitoring, it is reasonable to assume that marine mammals would be reliably detected within approximately 660 m of the UXO/MEC being detonated such that the potential for mortality or non-auditory injury is considered *de minimis*.

To estimate the maximum ensonified zones that could result from UXO/MEC detonations, the largest E12 $R_{95\%}$ to PTS and TTS threshold isopleths within the RWEC, Tables 18 and 20, respectively, were used as radii to calculate the area of a circle (pi × r^2 where r is the range to the threshold level) for each marine mammal hearing group. The results represent the largest area potentially ensonified above threshold levels from a single detonation within the RWEC corridor. The same method was used to calculate the maximum ensonified area from a single detonation in the lease area, based on the distances in Tables 19 and 21. Again, modeling results are presented here for mitigated (*i.e.*, using a noise abatement system) detonations of UXO/MECs (Tables 18-21). The results for unmitigated detonations can be found in Tables 44-48 in the ITA application. As noted previously, Revolution Wind has committed to the mitigated scenario; therefore, for take estimation, Revolution Wind assumes that a minimum of 10-dB of noise produced by a detonation would be attenuated using a noise abatement system. Thus, the mitigated maximum ensonified area for each hearing group for the largest UXO/MEC class was used for take estimation.

Table 18. Largest SEL-based $R_{95\%}$ PTS-Onset Ranges (In Meters) From Sites S1 and S2 (RWEC) Modeled During UXO/MEC Detonation, Assuming 10-dB Attenuation

Marine Mammal Hearing Group	Distance (m) to PTS Threshold During E12 (454 kg) detonation		Maximum Ensonified Zone (km^2)
	R_{max}	$R_{95\%}$	
Low-frequency cetaceans	4,270	3,780	44.9
Mid-frequency cetaceans	535	461	0.67
High-frequency cetaceans	6,960	6,200	121
Phocid pinnipeds (in water)	1,830	1,600	8.04

Table 19. Largest SEL-based $R_{95\%}$ PTS-Onset Ranges (In Meters) Sites S3 and S4 (Lease Area) Modeled During UXO/MEC Detonation, Assuming 10-dB Attenuation

Marine Mammal Hearing Group	Distance (m) to PTS Threshold During E12 (454 kg) detonation		Maximum Ensonified Zone (km^2)
	R_{max}	$R_{95\%}$	
Low-frequency cetaceans	3,900	3,610	40.9
Mid-frequency cetaceans	484	412	0.53
High-frequency cetaceans	6,840	6,190	12.0
Phocid pinnipeds (in water)	1,600	1,480	6.88

Table 20 -- Largest SEL-based $R_{95\%}$ TTS-onset Ranges (In Meters) From Sites S1 and S2 (RWEC) Modeled During UXO/MEC Detonation, Assuming 10-dB Attenuation

Marine Mammal Hearing Group	Distance (m) to TTS Threshold During E12 (454 kg) detonation		Maximum Ensonified Zone (km^2)
	R_{max}	$R_{95\%}$	
Low-frequency cetaceans	13,200	11,900	445
Mid-frequency cetaceans	2,820	2,550	4.40
High-frequency cetaceans	15,400	14,100	624
Phocid pinnipeds (in water)	7,610	6,990	153

Table 21. Largest SEL-based $R_{95\%}$ TTS-onset Ranges (In Meters) From Sites S3 and S4 (Lease Area) Modeled During UXO/MEC Detonation, Assuming 10-dB Attenuation

Marine Mammal Hearing Group	Distance (m) to TTS Threshold During E12 (454 kg) detonation		Maximum Ensonified Zone (km^2)
	R_{max}	$R_{95\%}$	
Low-frequency cetaceans	13,500	11,800	437
Mid-frequency cetaceans	2,730	2,480	19.3
High-frequency cetaceans	15,600	13,700	589
Phocid pinnipeds (in water)	7,820	7,020	155

Regarding the marine mammal density and occurrence data used in the take estimates for UXO/MECs, to avoid any in situ detonations of UXO/MECs during periods when North Atlantic right whale densities are highest in and near the RWEC corridor and lease area, Revolution Wind has opted for a temporal restriction to not detonate in Federal waters from December 1 through April 30 annually. Accordingly, for each species, they selected the highest average monthly marine mammal density between May and November (Roberts and Halpin (2022)) to conservatively estimate exposures from UXO/MEC detonation for a given species in any given year (*i.e.*, assumed all 13 UXO/MECs would be detonated in the month with the greatest average density). This approach is similar to what was used for determining the most appropriate species densities for monopile foundation installation. Furthermore, given that UXOs/MECs detonations have the potential to occur anywhere within the project area, a 15 km (9.32 mi) perimeter was applied around the lease area (reduced from the 50 km (31 mi) perimeter in the ITA application) and a 10 km (6.2 mi) perimeter was applied to the RWEC corridor (see Figures 12 and 13 of the Updated Density and Take Estimation

Memo). In some cases where monthly densities were unavailable, annual densities were used instead for certain species (*i.e.,* blue whales, pilot whale *spp*.).

Table 22 provides those densities and the associated months in which the species-specific densities are highest for the RWEC corridor and lease area, respectively.

Table 22. Maximum Of Average Monthly Marine Mammal Densities (Individuals/km^2) Within 15 Km of the RWEC Corridor and Lease Area (May-November), and Associated Month

Species	RWEC		Lease Area	
	Maximum Density	Maximum Density Month	Maximum Density	Maximum Density Month
Blue whale*	0.0000	Annual	0.0000	Annual
Fin whale*	0.0015	July	0.0029	July
Humpback whale	0.0014	May	0.0020	May
Minke whale	0.0110	May	0.0167	May
North Atlantic right whale*	0.0009	May	0.0019	May
Sei whale*	0.0007	May	0.0012	May
Atlantic spotted dolphin	0.0002	October	0.0007	October
Atlantic white-sided dolphin	0.0086	May	0.0175	May
Bottlenose dolphin	0.0047	July	0.0093	August

Common dolphin	0.0389	November	0.0762	September
Harbor porpoise	0.0218	May	0.0392	May
Pilot whales	0.0001	Annual	0.0007	Annual
Risso’s dolphin	0.0003	November	0.0006	November
Sperm whale*	0.0002	August	0.0004	August
Grey Seal	0.0769	May	0.0692	May
Harbor Seal	0.1728	May	0.1554	May

** Denotes species listed under the Endangered Species Act*

To estimate take incidental to UXO/MEC detonations in the RWEC corridor, the maximum ensonified areas based on the largest $R_{95\%}$ to Level A harassment (PTS) and Level B harassment (TTS) thresholds (assuming 10-dB attenuation) from a single detonation in the RWEC corridor, shown in Tables 18 and 20, were multiplied by six (the estimated number of UXOs/MECs that may be encountered in the RWEC corridor) and then multiplied by the marine mammal densities shown in Table 22, resulting in the take estimates in Table 23. For the lease area, the same method was applied, using the maximum ensonified areas in Tables 19 and 21 multiplied by seven (the estimated number of UXOs/MECs that may be encountered in the lease area) and then multiplied by the marine mammal densities shown in Table 22, resulting in the values shown in the columns for the lease area (with the heading “LA”) of Table 23. Again, Revolution Wind based the amount of requested take on the number of exposures estimated assuming 10-dB attenuation using a noise abatement system because they believe consistent, successful implementation of this mitigation measure would be possible.

Revolution Wind has proposed mitigation and monitoring measures intended to avoid Level A take of most species, and the extent and severity of Level B harassment (see **Proposed Mitigation** and **Proposed Monitoring and Reporting** sections below). However, given the relatively large distances to the high-frequency cetacean Level A harassment (PTS, SEL_{cum}) isopleth applicable to harbor porpoises, and the difficulty detecting this species at sea, Revolution Wind is requesting take by Level A harassment of 49 harbor porpoises. Similarly, seals are difficult to detect at longer ranges and, although the distance to the phocid hearing group SEL PTS threshold is not as large as that for high-frequency cetaceans, it may not be possible to detect all seals within the threshold distances even with the proposed monitoring measures. Therefore, in addition to the requested Level B harassment in Table 23, Revolution Wind requested Level A harassment of three gray seals and five harbor seals. However, NMFS has adjusted the amount of take proposed for authorization to seven gray seals and 16 harbor seals to correct for Revolution Wind's arithmetic error in the application and Updated Density and Take Estimation memo when summing the density-based Level A exposures for the lease area and export cable route for each species.

Table 23. Total (5-Year) and Maximum Annual Amount of Level A Harassment (PTS) and Level B Harassment Proposed to be Authorized From 13 UXO/MEC Detonations Assuming 10-dB Attenuation

Species	Level A Take		Total Level A Density-based Take Estimate	Level B Take		Total Level B Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Maximum Annual Level A Take	Maximum Annual Level B Take	5-year Total (Level A + Level B)
	LA[1]	ECR[2]		LA	ECR						
Mysticetes											
Blue Whale*	0.0	0.0	0.0	0.0	0.0	0.1	-	1.0	0	1	1
Fin Whale*	0.8	0.4	1.2	8.9	7.8	16.7	2.5	1.8	0	17	17
Humpback Whale	0.6	0.4	0.9	6.1	5.3	11.4	7.6	2.0	0	12	12
Minke Whale	4.8	3.0	7.7	51.1	44.6	95.7	0.9	1.2	0	96	96
North Atlantic Right Whale*	0.6	0.2	0.8	6.0	5.2	11.2	0.2	2.4	0	12	12
Sei Whale*	0.4	0.2	0.5	3.8	3.3	7.0	0.1	1.6	0	8	8
Odontocetes											
Atlantic Spotted Dolphin	0.0	0.0	0.0	0.1	0.1	0.2	-	29.0	0	29	29
Atlantic White-Sided Dolphin	0.1	0.0	0.1	2.4	2.1	4.5	0.7	27.9	0	28	28
Bottlenose Dolphin	0.0	0.0	0.1	1.3	1.1	2.4	8.3	7.8	0	9	9
Common Dolphin	0.3	0.2	0.4	10.3	9.3	19.6	210.1	34.9	0	211	211
Harbor Porpoise	33.1	15.8	48.9	161.9	147.0	308.9	0.2	2.7	49	309	358
Pilot Whales	0.0	0.0	0.0	0.1	0.1	0.2	-	8.4	0	9	9
Risso's Dolphin	0.0	0.0	0.0	0.1	0.1	0.2	0.6	5.4	0	6	6
Sperm Whale*	0.0	0.0	0.0	0.1	0.0	0.1	-	1.5	0	2	2

Pinnipeds											
Gray Seal	3.3	3.7	7	75.0	63.7	138.7	0.6	0.4	7	139	146
Harbor Seal	7.5	8.3	15.8	168.5	143.2	311.6	0.7	1.0	16	312	328

* *Denotes species listed under the Endangered Species Act*

[1] *LA = Lease Area*

[2] *ECR = Export Cable Route*

Temporary Cofferdam Installation and Removal

Acoustic modeling, using JASCO's MONM-BELLHOP model (used for modeling impact pile driving), was performed for Ørsted's Sunrise Wind Farm project to determine distances to the Level A harassment and Level B harassment isopleths resulting from installation of steel sheet piles to construct cofferdams and installation of casing pipes using pneumatic hammering (Kusel *et al.*, 2022b). Revolution Wind would install the same type of sheet piles and casing pipe in a similar location using the exact same methods as Sunrise Wind used to inform a published analysis, therefore the modeling results described for Sunrise Wind (Kusel *et al.*, 2022b) and presented here are considered applicable to Revolution Wind's project. For take assessment purposes, the sheet pile cofferdam scenario results in a larger amount of take by Level B harassment and is, therefore, analyzed further in the **Estimated Take** section. This is because acoustic propagation modeling predicts that the distance to the Level B harassment threshold isopleth produced by vibratory pile driving is approximately 10 km, while the distance to the same isopleth produced by pneumatic hammering is approximately 0.92 km. The sheet pile cofferdam scenario would require up to 56 days of vibratory hammer use for installation and removal, while the casing pipe scenario would require up to 12 days of vibratory pile driving (plus 8 days of pneumatic hammering). The larger number of total days of pile driving for the sheet pile cofferdam scenario coupled with the fact that vibratory pile driving on all of those days would produce the larger Level B harassment zone means the anticipated take, by Level B harassment, from the sheet pile cofferdam scenario would necessarily be higher and is, therefore, carried forward as the more conservative Level B harassment assumption. The acoustic ranges to the Level A harassment (SEL_{cum}) thresholds from impact pile driving (pneumatic hammering) of the casing pipe are estimated to be the following for each hearing group: low frequency = 3.87 km, mid frequency = 0.23 km, high frequency = 3.95 km, and phocid pinnipeds =

1.29 km. Level A harassment (SPL_{pk}) thresholds are not expected to be generated by pneumatic hammering. The estimated distances to Level A harassment SEL_{cum} thresholds are larger than the distance to the Level B harassment threshold (920 m). This is due to the high strike rate of the pneumatic hammer resulting in a high number of accumulated strikes per day. However, cetaceans are not expected to occur frequently close to this nearshore site, and individuals of any species (including seals) are not expected to remain within the estimated SEL_{cum} threshold distances for the entire 3-hour duration of hammering in a day. Given that work would occur within Narragansett Bay, the short duration of pneumatic hammering, and the implementation of mitigation and monitoring measures (including shutdown zones equivalent to the size of the Level A harassment zones), Level A harassment incidental to casing pipe installation is not expected or proposed for authorization. In addition, given the nature of vibratory pile driving and the small distances to Level A harassment thresholds (5-190 m), sheet pile cofferdam installation is also not expected to result in Level A harassment. Revolution Wind did not request, nor is NMFS proposing to authorize, any Level A harassment incidental to installation of sheet pile cofferdams or the casing pipe scenario.

In summary, the Level B harassment zone produced by vibratory pile driving (9.74 km) is significantly larger than that produced by pneumatic hammering (0.92 km). Additionally, as mentioned previously, the sheet pile cofferdam scenario would require up to a total of 56 days of vibratory pile driving for installation and removal, while the casing pipe scenario would require up to 24 days of vibratory pile driving plus 8 days of pneumatic hammering. The larger spatial impact combined with the longer duration of sheet pile cofferdam installation would produce a larger amount of Level B harassment; therefore, this landfall construction activity was carried forward as the most conservative scenario.

JASCO used its MONM-BELLHOP to predict acoustic propagation for frequencies between 5 Hz and 25 kHz produced by vibratory pile driven installation of the steel sheet piles that would be used to construct temporary cofferdams (Kusel *et al.*, 2022b). Acoustic propagation modeling was based on a winter sound speed profile, which was deemed both conservative and appropriate for the Revolution Wind project because use of the profile generates larger distances to Level A harassment and Level B harassment isopleths (versus those generated using a summer sound speed profile). Additional modeling assumptions are included in Table 24.

Decidecade band SEL levels were obtained from vibratory pile driving measurements available in the literature (Illingworth and Rodkin, 2017). The Illingworth and Rodkin (2017) measurements are for vibratory driving of four 12-in wide connected sheet piles (48 inch/122 cm total width) using an APE Model 300 vibratory hammer (1842.0 kN centrifugal force). Illingworth and Rodkin (2017) included SEL at 10 m from the pile in the frequency band 5–25,000 Hz. The average (from 10 piling measurements) maximum broadband SEL was 182.7 dB re 1 $\mu Pa^2 \cdot s$. For modeling of vibratory driving of sheet piles at the HDD location, SEL band levels were corrected for spherical spreading (+20 dB, corresponding to 10 m range) (Kusel *et al*., 2021).

Additional details on the acoustic modeling conducted for the Sunrise Wind project can be found in the Sunrise Wind Farm Project Underwater Noise and Exposure Modeling report available on NMFS' website at *https://www.fisheries.noaa.gov/action/incidental-take-authorization-sunrise-wind-llc-construction-and-operation-sunrise-wind*.

Table 24. Sheet Pile Installation Acoustic Modeling Assumptions

Parameter	Model Input
Vibratory Hammer	APE 300
Pile Type	Sheet Pile
Pile Length	30 m
Pile Width	0.6 m

Pile Wall Thickness	2.54 cm
Seabed Penetration	10 m
Time to Install 1 Pile	2 hrs
Number of Piles per Day	4

Similar to the modeling approach for impact pile driving, distances to harassment thresholds are reported as $R_{95\%}$ values (Table 25). Distances to the Level A harassment threshold are relatively small, ranging from 5 m for low-frequency cetaceans to 190 m for high-frequency cetaceans. The distance to the Level B harassment threshold is 9,740 m for all species.

Table 25. Acoustic Ranges ($R_{95\%}$) in Meters to Level A Harassment (PTS) and Level B Harassment Thresholds From Vibratory Pile Driving, Assuming a Winter Sound Speed Profile

$R_{95\%}$ (m)		
Marine Mammal Hearing Group	Level A Harassment SEL_{cum} Thresholds (dB re 1 μPa^2·s)	Level B Harassment SPL_{rms} Threshold (120 dB re 1 μPa)
Low-frequency	5	9,740
Mid-frequency	-	9,740
High-frequency	190	9,740
Phocid pinniped	10	9,740

Accounting for the effects that nearby land would have on sound propagation using a geographic information system (GIS) (ESRI, 2017) results in a reduction in the estimated area of 54.1 km^2 (20.9 mi^2) potentially being ensonified above the 120 dB threshold. As a cautionary approach, this 54.1 km^2 (20.9 mi^2) includes some areas beyond 9.74 km (6.05 mi) from the landfall location and reflects the maximum area potentially ensonified above threshold levels from construction activities at that site, including if a larger vibratory pile driving hammer were to be used.

Regarding how density and occurrence information was applied in estimating take for these activities, the export cable landfall construction work would take place near Quonset Point in North Kingstown, Rhode Island, which is within Narragansett Bay.

However, the habitat-based marine mammal densities from Roberts and Halpin (2022) do not include waters within Narragansett Bay. As an alternative, densities calculated from the area immediately outside of Narragansett Bay were used in exposure estimation. This is a conservative approach since there have been few reported sightings of marine mammals, other than seals, within Narragansett Bay (Raposa, 2009).

To select marine mammal density grid cells from the Roberts and Halpin (2022) data representative of the area just outside of Narragansett Bay, a zone representing the ensonified area plus a 5-km buffer from the mouth of Narragansett Bay was created in GIS (ESRI, 2017). This buffer was then intersected with the density grid cells for each individual species to select those near the mouth of Narragansett Bay (Figure 8 in Revolution Wind's Updated Density and Take Estimation Memo). Since the timing of landfall construction could vary somewhat from the proposed schedule, the maximum average monthly density from January through December for each species was selected (Table 26) and used to estimate exposures from landfall construction.

Table 26. Maximum Average Monthly Marine Mammal Densities In and Near the Mouth of Narragansett Bay and the Month in Which Each Maximum Density Occurs

Species	Maximum Monthly Density (Ind/km^2)	Maximum Density Month
Mysticetes		
Blue Whale*	0.0000	Annual
Fin Whale*	0.0000	-
Humpback Whale	0.0004	December
Minke Whale	0.0005	May
North Atlantic Right Whale*	0.0002	March
Sei Whale*	0.0002	April
Odontocetes		
Atlantic Spotted Dolphin	0.0000	-
Atlantic White-Sided Dolphin	0.0004	November
Bottlenose Dolphin	0.0002	September
Common Dolphin	0.0065	November
Harbor Porpoise	0.0125	December
Pilot Whales	0.0000	-
Risso's Dolphin	0.0000	-
Sperm Whale*	0.0000	-

Pinnipeds		
Gray seal	0.128	October
Harbor seal	0.204	October

** Denotes species listed under the Endangered Species Act*

Cable Landfall Construction Take Estimation

Given the short duration of the activity and shallow, coastal location, animat exposure modeling was not conducted for cofferdam installation and removal to determine potential exposures from vibratory pile driving. Rather, the modeled acoustic ranges to Level A harassment and Level B harassment isopleths were used to calculate the area around the cofferdam predicted to be ensonified daily to levels that exceed the thresholds, or the Ensonified Area. The Ensonified Area was calculated as the following:

$$Ensonified\ Area = pi*r^2,$$

Where r is the linear acoustic range from the source to the Level A harassment and Level B harassment isopleths.

To calculate density-based exposures estimates incidental to installation of two cofferdams, the average marine mammal densities from Table 26 were multiplied by the daily ensonified area (54.1 km^2) for installation of sheet piles. Given that use of the vibratory hammer during cofferdam installation and removal may occur on up to 56 days, the daily estimated take was multiplied by 56 to produce the results shown in Table 27. However, as noted above, to be conservative, Revolution Wind has requested take by Level B harassment based on the highest exposures predicted among the density-based, PSO-based, or average group size-based estimates; the take proposed for authorization is indicated in column 5 of Table 27 below. Mysticete whales are unlikely to occur in the immediate vicinity of the activity or within Narragansett Bay (Raposa, 2009); therefore, Revolution Wind is not requesting and NMFS is not proposing to authorize, take of these species. Given the small distances to Level A harassment isopleths (shown in Table 25), Level A harassment incidental to this activity is not anticipated, even absent mitigation.

Therefore, Revolution Wind is not requesting and NMFS is not proposing to authorize Level A take.

Table 27. Estimated Level B Harassment Incidental To Cofferdam Construction

Species	Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
Odontocetes				
Atlantic Spotted Dolphin	0.1	-	29.0	29
Atlantic White-Sided Dolphin	1.2	3.2	27.9	28
Bottlenose Dolphin	0.5	35.5	7.8	36
Common Dolphin	19.6	904.9	34.9	905
Harbor Porpoise	37.8	0.9	2.7	38
Pilot Whales	0.0	-	8.4	9
Risso's Dolphin	0.1	2.5	5.4	6
Sperm Whale*	0.1	-	1.5	2
Pinnipeds				
Gray Seal	353.5	2.5	1.4	354
Harbor Seal	794.3	3.2	1.4	795

** Denotes species listed under the Endangered Species Act*

HRG Surveys

Revolution Wind's proposed HRG survey activity includes the use of impulsive (*i.e.,* boomers and sparkers) and non-impulsive (*e.g.,* CHIRP SBPs) sources. NMFS has concluded that Level A harassment is not a reasonably likely outcome for marine mammals exposed to noise from the sources proposed for use here, and the potential for Level A harassment is not evaluated further in this document. Please see Revolution Wind's application for details of a quantitative exposure analysis (*i.e.,* calculated distances to Level A harassment isopleths and Level A harassment exposures). Revolution Wind did not request, and NMFS is not proposing to authorize, take by Level A harassment incidental to HRG surveys.

For HRG surveys, in order to better consider the narrower and directional beams of some of the sources, NMFS has developed a tool for determining the sound pressure level (SPL_{rms}) at the 160-dB isopleth for the purposes of estimating the extent of Level B harassment isopleths associated with HRG survey equipment (NMFS, 2020). This methodology incorporates frequency-dependent absorption and some directionality to refine estimated ensonified zones. Revolution Wind used NMFS' methodology with additional modifications to incorporate a seawater absorption formula and account for energy emitted outside of the primary beam of the source. For sources that operate with different beamwidths, the maximum beam width was used, and the lowest frequency of the source (refer back to Table 2) was used when calculating the frequency-dependent absorption coefficient.

NMFS considers the data provided by Crocker and Fratantonio (2016) to represent the best available information on source levels associated with HRG equipment and, therefore, recommends that source levels provided by Crocker and Fratantonio (2016) be incorporated in the method described above to estimate ranges to the Level A harassment and Level B harassment isopleths. In cases when the source level for a specific type of HRG equipment is not provided in Crocker and Fratantonio (2016), NMFS recommends that either the source levels provided by the manufacturer be used, or, in instances where source levels provided by the manufacturer are unavailable or unreliable, a proxy from Crocker and Fratantonio (2016) be used instead. Revolution Wind utilized the following criteria for selecting the appropriate inputs into the NMFS User Spreadsheet Tool (NMFS, 2018):

(1) For equipment that was measured in Crocker and Fratantonio (2016), the reported SL for the most likely operational parameters was selected.

(2) For equipment not measured in Crocker and Fratantonio (2016), the best available manufacturer specifications were selected. Use of manufacturer specifications represent the absolute maximum output of any source and do not adequately represent the operational source. Therefore, they should be considered an overestimate of the sound propagation range for that equipment.

(3) For equipment that was not measured in Crocker and Fratantonio (2016) and did not have sufficient manufacturer information, the closest proxy source measured in Crocker and Fratantonio (2016) was used.

The Dura-spark measurements and specifications provided in Crocker and Fratantonio (2016) were used for all sparker systems proposed for the HRG surveys. These included variants of the Dura-spark sparker system and various configurations of the GeoMarine Geo-Source sparker system. The data provided in Crocker and Fratantonio (2016) represent the most applicable data for similar sparker systems with comparable operating methods and settings when manufacturer or other reliable measurements are not available. Crocker and Fratantonio (2016) provide S-Boom measurements using two different power sources (CSP-D700 and CSP-N). The CSP-D700 power source was used in the 700 joules (J) measurements but not in the 1,000 J measurements. The CSP-N source was measured for both 700 J and 1,000 J operations but resulted in a lower source level; therefore, the single maximum source level value was used for both operational levels of the S-Boom.

Table 2 identifies all the representative survey equipment that operates below 180 kHz (*i.e.*, at frequencies that are audible and have the potential to disturb marine mammals) that may be used in support of planned survey activities, and are likely to be detected by marine mammals given the source level, frequency, and beamwidth of the equipment.

Results of modeling using the methodology described above indicated that, of the HRG equipment planned for use by Revolution Wind that has the potential to result in Level B harassment of marine mammals, sound produced by the Applied Acoustics sparkers and Applied Acoustics triple-plate S-boom would propagate furthest to the Level B harassment isopleth (141 m; Table 28). For the purposes of take estimation, it was conservatively assumed that sparkers and/or boomers would be the dominant acoustic source for all vessel days (although, again, this may not always be the case). Thus, the range to the isopleth corresponding to the threshold for Level B harassment for and the boomer and sparkers (141 m) was used as the basis of take calculations for all marine mammals. This is a conservative approach, as the actual sources used on individual vessel days, or during a portion of a vessel day, may produce smaller distances to the Level B harassment isopleth.

Table 28. Distances To the Level B Harassment Thresholds For Each HRG Sound Source Or Comparable Sound Source Category For Each Marine Mammal Hearing Group

Equipment Type	Representative Model	Level B (m)
		All (SPL_{rms})
Sub-bottom Profiler	EdgeTech 216	9
	EdgeTech 424	4
	Edgetech 512	6
	GeoPulse 5430A	21
	Teledyn Benthos CHIRP III - TTV 170	48
Sparker	Applied Acoustics Dura-Spark UHD (700 tips, 1,000 J)	34
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	141
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	141
Boomer	Applied Acoustics triple plate S- Boom (700–1,000 J)	141

To estimate densities for the HRG surveys occurring both within the lease area and within the RWEC based on Roberts and Halpin (2022), a 5-km (3.11 mi) perimeter was applied around each area (see Figures 10 and 11 of the Updated Density and Take Estimation Memo). Given this work could occur year-round, the annual average density for each species was calculated using average monthly densities from January through December (Table 29).

Table 29. Annual Average Marine Mammal Densities Along the RWEC Corridor and Lease Area

Species	RWEC corridor Annual Average Density (Ind/km^2)	Lease Area Annual Average Density (Ind/km^2)
Mysticetes		
Blue Whale*	0.0000	0.0000
Fin Whale*	0.0008	0.0016
Humpback Whale	0.0008	0.0010
Minke Whale	0.0022	0.0044
North Atlantic Right Whale*	0.0011	0.0027
Sei Whale*	0.0003	0.0004
Odontocetes		
Atlantic Spotted Dolphin	0.0000	0.0001
Atlantic White-Sided Dolphin	0.0038	0.0090
Bottlenose Dolphin	0.0021	0.0049
Common Dolphin	0.0202	0.0409
Harbor Porpoise	0.0191	0.0316
Pilot Whales	0.0001	0.0005
Risso's Dolphin	0.0001	0.0003
Sperm Whale*	0.0001	0.0001
Pinnipeds		
Seals (Harbor and Gray)	0.1477	0.1182

** Denotes species listed under the Endangered Species Act*

The maximum range (*i.e.*, 141 m) to the Level B harassment threshold and the estimated trackline distance traveled per day by a given survey vessel (*i.e.*, 70 km) were used to calculate the daily ensonified area, or zone of influence (ZOI) around the survey vessel.

The ZOI is a representation of the maximum extent of the ensonified area around a HRG sound source over a 24-hr period. The ZOI for each piece of equipment operating at or below 180 kHz was calculated per the following formula:

ZOI = (Distance/day × 2r) + pi*r^2

Where r is the linear distance from the source to the harassment isopleth.

The largest daily ZOI (19.8 km^2), associated with the proposed use of boomers and sparkers, was applied to all planned vessel days.

Potential Level B density-based harassment exposures are estimated by multiplying the average annual density of each species within the survey area by the daily ZOI. That product was then multiplied by the number of planned vessel days in each sector during the approximately 1-year construction timeframe (82.1 in RWEC corridor, 165.7 in lease area), and the product was rounded to the nearest whole number. These results are shown in columns 2 (lease area) and 3 (RWEC corridor) of Table 30. Similar to the approach described above, to be conservative, Revolution Wind has requested take by Level B harassment based on the highest exposures predicted by the density-based, PSO based, or average group size-based estimates, and the take proposed for authorization is indicated in column 7 of Table 30 below.

Table 30. Estimated Take, by Level B Harassment, Incidental To HRG Surveys During the Construction Period (Year 1)

Construction Phase Density-based Exposures by Survey Area			Total Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
Species	Lease Area	RWEC Corridor				
Mysticetes						
Blue Whale*	0.0	0.0	0.0	-	1.0	1
Fin Whale*	4.4	1.4	5.8	6.6	1.8	7
Humpback Whale	2.8	1.2	4.0	16.5	2.0	17
Minke Whale	11.8	3.7	15.5	5.9	1.2	16
North Atlantic Right Whale*	7.4	1.8	9.2	-	2.4	10
Sei Whale*	1.1	0.4	1.6	-	1.6	2
Odontocetes						
Atlantic Spotted Dolphin	0.3	0.1	0.3	-	29.0	29
Atlantic White-Sided Dolphin	24.5	6.5	31.0	-	27.9	31
Bottlenose Dolphin	13.2	3.8	17.0	100.1	7.8	101
Common Dolphin	110.5	33.5	144.0	2,353.4	34.9	2,354
Harbor Porpoise	85.4	30.9	116.3	-	2.7	117
Pilot Whales	1.4	0.1	1.5	-	8.4	9
Risso's Dolphin	0.8	0.2	1.0	2.3	5.4	6
Sperm Whale*	0.4	0.1	0.5	-	1.5	2
Pinnipeds						
Gray Seal	98.5	75.5	174.0	7.1	1.4	174
Harbor Seal	221.2	169.6	390.9	11.2	1.4	391

** Denotes species listed under the Endangered Species Act.*

Authorized takes would be by Level B harassment only, in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to noise from certain HRG acoustic sources. Based primarily on the characteristics of the signals produced by the acoustic sources planned for use, Level A harassment is neither anticipated (even absent mitigation), nor proposed to be authorized. Consideration of the anticipated effectiveness of the mitigation measures (*i.e.*, pre-start clearance and shutdown measures), discussed in detail below in the **Proposed Mitigation** section, further strengthens the conclusion that Level A harassment is not a reasonably expected outcome of the survey activity. No serious injury or mortality is anticipated or proposed to be authorized for this activity.

As mentioned previously, HRG surveys would also routinely be carried out during the period of time following construction of the RWF and RWEC corridor which, for the purposes of exposure modeling, Revolution Wind assumed to be four years. Revolution Wind estimates that HRG surveys would cover 2,117 km within the lease area and 1,642 km along the RWEC corridor annually. Assuming 70 km are surveyed per day, this amounts to 30.2 days of survey activity in the lease area and 23.5 days of survey activity along the RWEC each year, or 214.8 days total for the 4-year timeframe following the construction period (assuming all construction activities occur in a single year). Density-based take was estimated using the same approach outlined above by multiplying the daily ZOI by the annual average densities and separately by the number of vessel days planned for the RWEC and lease area; the results are shown in columns 2 and 3, respectively, in Table 31. Using the same approach described above, Revolution Wind estimated a conservative amount of annual take, by Level B harassment, based on the highest exposures predicted by the density-based, PSO-based, or average group size-based estimates. The highest predicted exposure value was multiplied by four to yield the amount of take Revolution Wind requested and that is proposed for authorization, shown in column 8 of Table 31 below.

Table 31. Estimated Take, By Level B Harassment, From HRG Surveys During Non-construction Years (Years 2-5) and Total 4-year Take

Annual Operations Phase Density-based Exposures by Survey Area			Annual Total Density-based Exposures	Annual PSO Data Take Estimate	Mean Group Size	Highest Annual Level B Take (Years 2-5)	4-year Level B Take
Species	Lease Area	RWEC corridor					
Mysticetes							
Blue Whale*	0.0	0.0	0.0	-	1.0	1	4
Fin Whale*	1.0	0.4	1.3	1.6	1.8	2	8
Humpback Whale	0.6	0.4	1.0	4.0	2.0	5	20
Minke Whale	2.6	1.0	3.6	1.5	1.2	4	16
North Atlantic Right Whale*	1.6	0.5	2.1	-	2.4	3	12
Sei Whale*	0.3	0.1	0.4	-	1.6	2	8
Odontocetes							
Atlantic Spotted Dolphin	0.1	0.0	0.1	-	29.0	29	116
Atlantic White-Sided Dolphin	5.4	1.8	7.2	-	27.9	28	112
Bottlenose Dolphin	2.9	1.0	3.9	24.6	7.8	25	100
Common Dolphin	24.5	9.4	33.8	578.0	34.9	579	2,316
Harbor Porpoise	18.9	8.9	27.8	-	2.7	28	112
Pilot Whales	0.3	0.0	0.3	-	8.4	9	36
Risso's Dolphin	0.2	0.1	0.2	0.6	5.4	6	24
Sperm Whale*	0.1	0.0	0.1	-	1.5	2	8
Pinnipeds							
Gray Seal	27.2	21.1	48.3	1.7	1.4	49	196
Harbor Seal	61.1	47.5	108.6	2.7	1.4	109	436

** Denotes species listed under the Endangered Species Ac*

Total Proposed Take Across All Activities

Level A harassment and Level B harassment proposed take numbers for the combined activities of impact pile driving (assuming 10-dB of sound attenuation) during the installation of monopiles; vibratory pile driving for cofferdam installation and removal; HRG surveys; and potential UXO/MEC detonation(s) (assuming 10-dB attenuation) are provided by year in Table 32. The mitigation and monitoring measures provided in the **Proposed Mitigation** and **Proposed Monitoring and Reporting** sections are activity-specific and are designed to minimize acoustic exposures to marine mammal species.

The take numbers NMFS proposes for authorization (Table 32) are considered conservative for the following key reasons:

- Proposed take numbers assume installation of three piles per day to estimate the potential for Level A harassment, and assumed all foundation piles (n=81) would be installed in the month with the highest average annual density for each marine mammal species;
- Proposed take numbers for vibratory pile driving assume that two sheet pile temporary cofferdams will be installed (versus the alternative installation of a gravity cell cofferdam, for which no take is anticipated);
- Proposed take numbers for pile driving are conservatively based on the highest average monthly densities across the proposed construction months; and,
- Proposed Level A harassment take numbers do not fully account for the likelihood that marine mammals would avoid a stimulus when possible before the individual accumulates enough acoustic energy to potentially cause auditory injury, or the effectiveness of the proposed

monitoring and mitigation measures (with the exception of North Atlantic right whales, given the extensive mitigation measures proposed for this species).

The Year 1 take estimates include 218.7 days of HRG surveys, impact installation of WTG and OSS foundations, cofferdam installation/removal, and mitigated UXO/MEC detonations. Year 2 includes 53.7 days of HRG surveys, and potential impact installation of WTG and OSS monopile foundations, depending on whether or not delays in the schedule for Year 1 occur. Years 3, 4, and 5 each include 53.7 days of HRG surveys. Although temporary cofferdam installation/removal could occur in Year 2, all of the proposed takes were allocated to Year 1 as this represents the most accurate construction scenario. All impact pile driving activities for the WTGs and OSSs could also occur outside of Year 1; however, all of the takes were allocated to Year 1 as this represents the most likely scenario.

Table 32. Estimated Level A Harassment and Level B Harassment Takes For All Activities Proposed to be Conducted During the Revolution Wind Offshore Wind Energy Facility Project (2023-2028)

Species	NMFS Stock Abundance	Year 1 (Maximum)		Year 2		Year 3		Year 4		Year 5		5-year Total	
		Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B
Mysticetes													
Blue Whale*	412[1]	0	3	0	1	0	1	0	1	0	1	0	7
Fin Whale*	6,802	0	40	0	2	0	2	0	2	0	2	0	48
Humpback Whale	1,396	7	77	0	5	0	5	0	5	0	5	7	97
Minke Whale	21,968	0	304	0	4	0	4	0	4	0	4	0	32
North Atlantic Right Whale*	368	0	44	0	3	0	3	0	3	0	3	0	56
Sei Whale*	6,292	0	18	0	2	0	2	0	2	0	2	0	26
Odontocetes													
Atlantic Spotted Dolphin	39,921	0	87	0	29	0	29	0	29	0	29	0	203
Atlantic White-sided Dolphin	93,233	0	260	0	28	0	28	0	28	0	28	0	372
Bottlenose Dolphin	62,851	0	180	0	25	0	25	0	25	0	25	0	280
Common Dolphin	172,974	0	3,913	0	579	0	579	0	579	0	579	0	6,229

Harbor Porpoise	95,543	49	1,125	0	28	0	28	0	28	0	28	49	1,237
Pilot Whales	68,139	0	27	0	9	0	9	0	9	0	9	0	63
Risso's Dolphin	35,215	0	28	0	6	0	6	0	6	0	6	0	52
Sperm Whale*	4,349	0	7	0	2	0	2	0	2	0	2	0	15
Pinnipeds													
Gray Seal	27,300	7	978	0	49	0	49	0	49	0	49	7	1,174
Harbor Seal	61,336	16	2,393	0	109	0	109	0	109	0	109	16	2,829

** Listed as Endangered under the Endangered Species Act (ESA).*
1 - The minimum blue whale population is estimated at 412, although the exact value is not known. NMFS is utilizing this value for our preliminary small numbers determination, as shown in parenthesis.

In making the negligible impact determination and the necessary small numbers finding, NMFS assesses the greatest number of proposed take of marine mammals that could occur within any one year, which in the case of this rule is based on the predicted Year 1 for all species. In this calculation, the maximum estimated number of Level A harassment takes in any one year is summed with the maximum estimated number of Level B harassment takes in any one year for each species to yield the highest amount of estimated take that could occur in any year. We recognize that certain activities could shift within the 5-year effective period of the rule; however, the rule allows for that flexibility and the takes are not expected to exceed those shown in **Table 33** in any year.

Table 33. Maximum Number Of Requested Takes (Level A Harassment and Level B Harassment) That Could Occur In Any One Year Of The Project

Species	NMFS Stock Abundance	Maximum Annual Take Proposed for Authorization			
		Max Level A Harassment	Max Level B harassment	Max Annual Take (Max Level A Harassment + Max Level B Harassment)	Total Percent Stock Taken Based on Maximum Annual Take[1]
Mysticetes					
Blue Whale*	412 [2]	0	3	3	0.73
Fin Whale*	6,802	0	40	40	0.59
Humpback Whale	1,396	7	77	94	6.67
Minke Whale	21,968	0	304	304	1.38
North Atlantic Right Whale*	368	0	44	44	12.0
Sei Whale*	6,292	0	18	18	0.29
Odontocetes					
Atlantic Spotted Dolphin	39,921	0	87	87	0.22
Atlantic White-sided Dolphin	93,233	0	260	260	0.28
Bottlenose Dolphin	62,851	0	180	180	0.29

Common Dolphin	172,974	0	3,913	3,913	2.26
Harbor Porpoise	95,543	49	1,125	1,125	1.18
Pilot Whales	68,139	0	27	27	0.04
Risso's Dolphin	35,215	0	28	28	0.08
Sperm Whale*	4,349	0	7	7	0.16
Pinnipeds					
Gray Seal	27,300	7	978	985	3.60
Harbor Seal	61,336	16	2,393	2,409	3.93

** Listed as Endangered under the Endangered Species Act (ESA).*
1 – Calculations of percentage of stock taken are based on the maximum requested Level A harassment take in any one year + the total requested Level B harassment take in any one year and then compared against the best available abundance estimate as shown in Table 5. For this proposed action, the best available abundance estimates are derived from the NMFS Stock Assessment Reports (Hayes et al., 2022).
2 - The minimum blue whale population is estimated at 412, although the exact value is not known. NMFS is utilizing this value for our preliminary small numbers determination, as shown in parenthesis.

Proposed Mitigation

In order to promulgate a rulemaking under section 101(a)(5)(A) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to the activity, and other means of effecting the least practicable impact on the species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stock for taking for certain subsistence uses (latter not applicable for this action). NMFS' regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting the activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, we carefully consider two primary factors:

(1) The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned), and;

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

The mitigation strategies described below are consistent with those required and successfully implemented under previous incidental take authorizations issued in association with in-water construction activities (*e.g.*, soft-start, establishing shutdown zones). Additional measures have also been incorporated to account for the fact that the proposed construction activities would occur offshore. Modeling was performed to estimate harassment zones, which were used to inform mitigation measures for pile driving activities to minimize Level A harassment and Level B harassment to the extent practicable, while providing estimates of the areas within which Level B harassment might occur.

Generally speaking, the measures considered and proposed here fall into three categories: temporal (seasonal and daily) work restrictions, real-time measures (shutdown, clearance zones, and vessel strike avoidance), and noise abatement/reduction measures. Seasonal work restrictions are designed to avoid or minimize operations when marine mammals are concentrated or engaged in behaviors that make them more susceptible, or make impacts more likely) in order to reduce both the number and severity of potential takes, and are effective in reducing both chronic (longer-term) and acute effects. Real-time measures, such as shutdown and pre-clearance zones, and vessel strike avoidance measures, are intended to reduce the probability or scope of near-term acute impacts by taking steps in real time once a higher-risk scenario is identified (*i.e.*, once animals are detected within an impact zone). Noise abatement measures, such as bubble curtains, are intended to reduce the noise at the source, which reduces both acute impacts, as well as the contribution to aggregate and cumulative noise that results in longer term chronic impacts.

Below, we describe training, coordination, and vessel strike avoidance measures that apply to all activity types, and then in the following subsections we describe the measures that apply specifically to WTG and OSS foundation installation, cofferdam or casing pipe scenario installation and removal, UXO/MEC detonations, HRG surveys, and fishery monitoring surveys.

Training and Coordination

Revolution Wind would be required to instruct all project personnel regarding the authority of the marine mammal monitoring team(s). For example, the *e.g.*, HRG acoustic equipment operator, pile driving personnel, etc., would be required to immediately comply with any call for a delay or shutdown by the Lead PSO. Any disagreement between the Lead PSO and the project personnel would only be discussed after delay or shutdown has occurred. All relevant personnel and the marine mammal monitoring team would be required to participate in joint, onboard briefings that would be led by Revolution Wind project personnel and the Lead PSO prior to the beginning of project activities. This would serve to ensure that all relevant responsibilities, communication procedures, marine mammal monitoring and mitigation protocols, reporting protocols, safety, operational procedures, and ITA requirements are clearly understood by all involved parties. The briefing would be repeated whenever new relevant personnel (*e.g.*, new PSOs, acoustic source operators, relevant crew) join the operation before work commences.

More information on vessel crew training requirements can be found in the *Vessel Strike Avoidance Measures* section below.

North Atlantic Right Whale Awareness Monitoring

Revolution Wind must use available sources of information on North Atlantic right whale presence, including daily monitoring of the Right Whale Sightings Advisory System, monitoring of Coast Guard VHF Channel 16 throughout each day to receive notifications of any sightings, and information associated with any regulatory management actions (*e.g.*, establishment of a zone identifying the need to reduce vessel speeds). Maintaining daily awareness and coordination affords increased protection of North Atlantic right whales by understanding North Atlantic right whale presence in the area through ongoing visual and passive acoustic monitoring efforts and opportunities (outside of Revolution Wind's efforts), and allows for planning of construction activities, when practicable, to minimize potential impacts on North Atlantic right whales.

Protected Species Observers and PAM Operator Training

Revolution Wind would employ NMFS-approved PSOs and PAM operators. The PSO field team and PAM team would have a lead member (designated as the "Lead PSO" or "PAM Lead") who would have prior experience observing mysticetes, odontocetes and pinnipeds in the Northwestern Atlantic Ocean on other offshore projects requiring PSOs. Any remaining PSOs and PAM operators must have previous experience observing marine mammals during projects and must have the ability to work with all required and relevant software and equipment. New and/or inexperienced PSOs would be paired with an experienced PSO to ensure that the quality of marine mammal observations and data recording is kept consistent.

All PSOs and PAM operators would be required to complete a Permits and Environmental Compliance Plan (PECP) training, as well as a two-day training and refresher session on monitoring protocols. These trainings would be held with the PSO provider and project compliance representatives and would occur before the start of project activities related to the construction and development of the Revolution Wind Offshore Wind Farm Project. PSOs would be required during all foundation installations, cofferdam or casing pipe installation/removal activities, UXO/MEC detonations, and HRG surveys. More information on requirements during each activity can be found in the **Proposed Monitoring and Reporting** section.

Vessel Strike Avoidance Measures

This proposed rule contains numerous vessel strike avoidance measures. Revolution Wind will be required to comply with these measures, except under circumstances when doing so would create an imminent and serious threat to a person or vessel, or to the extent that a vessel is unable to maneuver and, because of the inability to maneuver, the vessel cannot comply (*e.g.,* due to towing, etc.). Vessel operators and crews will receive protected species identification training prior to the start of in-water construction activities. This training will cover information about marine mammals and other protected species known to occur or which have the potential to occur in the project area. It will include training on making observations in both good weather conditions (*i.e.*, clear visibility, low wind, and low sea state) and bad weather conditions (*i.e.*, fog, high winds and high sea states, in glare). Training will not only include identification skills, but will also include information and resources available regarding applicable Federal laws and regulations for protected species.

Revolution Wind will abide by the following vessel strike avoidance measures:

- All vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course (as appropriate) and regardless of vessel size, to avoid striking any marine mammal.
- During any vessel transits within or to/from the Revolution Wind project area, such as for crew transfers), an observer would be stationed at the best vantage point of the vessel(s) to ensure that the vessel(s) are maintaining the appropriate separation distance from marine mammals.
- Year-round and when a vessel is in transit, all vessel operators will continuously monitor U.S. Coast Guard VHF Channel 16 over which North Atlantic right whale sightings are broadcasted.
- At the onset of transiting and at least once every four hours, vessel operators and/or trained crew members will monitor the project's Situational Awareness System, WhaleAlert, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales Any observations of any large whale by any Revolution Wind staff or contractors, including vessel crew, must be communicated immediately to PSOs, PAM operator, and all vessel captains to increase situational awareness. Conversely, any large whale observation or detection via a sighting network (*e.g.*, Mysticetus) by PSOs or PAM operators will be conveyed to vessel operators and crew.
- All vessels would comply with existing NMFS regulations and speed restrictions and state regulations as applicable for North Atlantic right whales.
- In the event that any Slow Zone (designated as a Dynamic Management Area (DMA)) is established that overlaps with an area where a project-associated vessel would operate, that vessel, regardless of size, will transit that area at 10 knots or less.

- Between November 1st and April 30th, all vessels, regardless of size, would operate port to port (specifically from ports in New Jersey, New York, Maryland, Delaware, and Virginia) at 10 knots or less, except for vessels while transiting in Narragansett Bay or Long Island Sound (which have not been demonstrated by best available science to provide consistent habitat for North Atlantic right whales).
- All vessels, regardless of size, would immediately reduce speed to 10 knots or less when any large whale, mother/ calf pairs, or large assemblages of non-delphinid cetaceans are observed near (within 500 m) an underway vessel.
- All vessels, regardless of size, would immediately reduce speed to 10 knots or less when a North Atlantic right whale is sighted, at any distance, by an observer or anyone else on the vessel.
- If a vessel is traveling at greater than 10 knots, in addition to the required dedicated visual observer, real-time PAM of transit corridors must be conducted prior to and during transits. If a North Atlantic right whale is detected via visual observation or PAM within or approaching the transit corridor, all crew transfer vessels must travel at 10 knots or less for the following 12 hours. Each subsequent detection will trigger a 12-hour reset. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor in the past 12 hours.
- All underway vessels (*e.g.*, transiting, surveying) must have a dedicated visual observer on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (*e.g.*, darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species

detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements in this proposed action. Visual observers may be third-party observers (*i.e.*, NMFS-approved PSOs) or crew members and must not have any other duties other than observing for marine mammals. Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Confirmation of the observers' training and understanding of the ITA requirements must be documented on a training course log sheet and reported to NMFS.

- All vessels must maintain a minimum separation distance of 500 m from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.
- If underway, all vessels must steer a course away from any sighted North Atlantic right whale at 10 knots or less such that the 500-m minimum separation distance requirement is not violated. If a North Atlantic right whale, or a large whale that cannot be confirmed as a species other than a North Atlantic right whale, is sighted within 500 m of an underway vessel, that vessel must shift the engine to neutral. Engines will not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.

- All vessels must maintain a minimum separation distance of 100 m from sperm whales and non-North Atlantic right whale baleen whales. If one of these species is sighted within 100 m of an underway vessel, that vessel must shift the engine to neutral. Engines will not be engaged until the whale has moved outside of the vessel's path and beyond 100 m.

- All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all delphinoid cetaceans and pinnipeds, with an exception made for those that approach the vessel (*e.g.*, bow-riding dolphins). If a delphinoid cetacean or pinniped is sighted within 50 m of an underway vessel, that vessel must shift the engine to neutral (again, with an exception made for those that approach the vessel). Engines will not be engaged until the animal(s) has moved outside of the vessel's path and beyond 50 m.

- When a marine mammal(s) is sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distances (*e.g.*, attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If a marine mammal(s) is sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engine(s) until the animal(s) is clear of the area. This does not apply to any vessel towing gear or any situation where respecting the relevant separation distance would be unsafe (*i.e.*, any situation where the vessel is navigationally constrained).

- All vessels underway must not divert or alter course in order to approach any marine mammal.

- For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal in on a path towards or comes within 10 m of equipment, Revolution Wind must cease operations until the marine mammal has moved more than 10 m on a path away from the activity to avoid direct interaction with equipment.

- Revolution Wind must submit a North Atlantic right whale vessel strike avoidance plan 180 days prior to commencement of vessel use. The plan would, at minimum, describe how PAM, in combination with visual observations, would be conducted to ensure the transit corridor is clear of right whales. The plan would also provide details on the vessel-based observer protocols on transiting vessels.

WTG and OSS Foundation Installation

For WTG and OSS foundation installation, NMFS is proposing to include the following mitigation requirements, which are described in detail below: seasonal and daily restrictions; the use of noise abatement systems; the use of PSOs and PAM operators; the implementation of clearance and shutdown zones, and the use of soft-start.

Seasonal and Daily Restrictions

No foundation impact pile driving activities would occur January 1 through April 30. Based on the best available information (Roberts and Halpin, 2022), the highest densities of North Atlantic right whales in the project area are expected during the months of January through April. NMFS is requiring this seasonal work restriction to minimize the potential for North Atlantic right whales to be exposed to noise incidental to impact pile driving of monopiles, which is expected to greatly reduce the number of takes of North Atlantic right whales.

No more than three foundation monopiles would be installed per day. Monopiles would be no larger than 15-m in diameter, representing the larger end of the tapered 7/15-m monopile design. For all monopiles, the minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 4,000 kJ.

Revolution Wind has requested authorization to initiate pile driving during nighttime when detection of marine mammals is visually challenging. To date, Revolution Wind has not submitted a plan containing the information necessary, including evidence, that their proposed systems are capable of detecting marine mammals, particularly large whales, at night and at distances necessary to ensure mitigation measures are effective. The available information on traditional night vision technologies demonstrates that there is a high degree of uncertainty in reliably detecting marine mammals at night at the distances necessary for this project (Smultea *et al*., 2021). Therefore, at this time, NMFS plans to only allow Revolution Wind to initiate pile driving during daylight hours, and prohibit Revolution Wind from initiating pile driving earlier than one hour after civil sunrise or later than 1.5 hours before civil sunset. We are, however, proposing to encourage and allow Revolution Wind the opportunity to further investigate and test advanced technology and detection systems to support their request. NMFS is proposing to condition the LOA such that nighttime pile driving would only be allowed if Revolution Wind submits an Alternative Monitoring Plan (as part of the Pile Driving and Marine Mammal Monitoring Plan) to NMFS for approval that proves the efficacy of their night vision devices (*e.g.*, mounted thermal/IR camera systems, hand-held or wearable night vision devices (NVDs), infrared (IR) spotlights) in detecting protected marine mammals prior to making a determination in the final rule. The plan must include a full description of the proposed technology, monitoring methodology, and supporting data demonstrating the reliability and effectiveness of the proposed technology in detecting marine mammal(s) within the clearance and shutdown zones for monopiles before and during impact pile driving. The Plan should identify the efficacy of the technology at detecting marine mammals in the clearance and shutdowns under all the various conditions anticipated during construction, including varying weather conditions, sea states, and in consideration of the use of artificial lighting.

Noise Abatement Systems

Revolution Wind would employ noise abatement systems (NAS), also known as noise attenuation systems, during all impact pile driving of monopiles to reduce the sound pressure levels that are transmitted through the water in an effort to reduce ranges to acoustic thresholds and minimize any acoustic impacts resulting from impact pile driving. Revolution Wind would be required to employ a big double bubble curtain or a combination of two or more NAS during these activities, as well as the adjustment of operational protocols to minimize noise levels.

Two categories of NAS exist: primary and secondary. A primary NAS would be used to reduce the level of noise produced by the pile driving activities at the source, typically through adjustments on to the equipment (*e.g.*, hammer strike parameters). Primary NAS are still evolving and will be considered for use during mitigation efforts when the NAS has been demonstrated as effective in commercial projects. However, as primary NAS are not fully effective at eliminating noise, a secondary NAS would be employed. The secondary NAS is a device or group of devices that would reduce noise as it was transmitted through the water away from the pile, typically through a physical barrier that would reflect or absorb sound waves and, therefore reducing the distance the higher energy sound propagates through the water column. Together, these systems must reduce noise levels to the lowest level practicable with the goal of not exceeding measured ranges to Level A harassment and Level B harassment isopleths corresponding to those modeled assuming 10-dB sound attenuation, pending results of sound field verification (SFV) (see the *Acoustic Monitoring for Sound Field and Harassment Isopleth Verification* section).

Noise abatement systems, such as bubble curtains, are used to decrease the sound levels radiated from a source. Bubbles create a local impedance change that acts as a barrier to sound transmission. The size of the bubbles determines their effective frequency band, with larger bubbles needed for lower frequencies. There are a variety of bubble curtain systems, confined or unconfined bubbles, and some with encapsulated bubbles or panels. Attenuation levels also vary by type of system, frequency band, and location. Small bubble curtains have been measured to reduce sound levels but effective attenuation is highly dependent on depth of water, current, and configuration and operation of the curtain (Austin *et al.*, 2016; Koschinski and Lüdemann, 2013). Bubble curtains vary in terms of the sizes of the bubbles and those with larger bubbles tend to perform a bit better and more reliably, particularly when deployed with two separate rings (Bellmann, 2014; Koschinski and Lüdemann, 2013; Nehls *et al.*, 2016). Encapsulated bubble systems (*e.g.*, Hydro Sound Dampers (HSDs)), can be effective within their targeted frequency ranges (*e.g.*, 100-800 Hz), and when used in conjunction with a bubble curtain appear to create the greatest attenuation. The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. Secondary NAS that may be used by Revolution Wind include a big bubble curtain (BBC), a hydro-sound damper (HSD), or an AdBm Helmholz resonator (Elzinga *et al.*, 2019). See Appendix B (Protected Species Mitigation and Monitoring Plan (PSMMP)) of the ITA application for more information on these systems (Revolution Wind, 2022b). If a single system is used, it must be a double big bubble curtain (dBBC). Other systems (*e.g.*, noise mitigation screens) are not considered feasible for the Revolution Wind project as they are in their early stages of development and field tests to evaluate performance and effectiveness have not been completed. Should the research and development phase of these newer systems demonstrate effectiveness, as part of adaptive management, Revolution Wind may submit data on the effectiveness of these systems and request approval from NMFS to use them during pile driving.

If a bubble curtain is used (single or double), Ørsted would be required to maintain the following operational parameters: The bubble curtain(s) must distribute air bubbles using a target air flow rate of at least 0.5 m^3/(min*m), and must distribute bubbles around 100 percent of the piling perimeter for the full depth of the water column. The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100-percent seafloor contact; no parts of the ring or other objects should prevent full seafloor contact. Revolution Wind must require that construction contractors train personnel in the proper balancing of airflow to the bubble ring, and must require that construction contractors submit an inspection/performance report for approval by Revolution Wind within 72 hours following the performance test. Corrections to the attenuation device to meet the performance standards must occur prior to impact driving of monopiles. If Revolution Wind uses a noise mitigation device in addition to a BBC, similar quality control measures would be required.

The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. Dähne *et al.* (2017) found that single bubble curtains that reduce sound levels by 7 to 10 dB reduced the overall sound level by approximately 12 dB when combined as a double bubble curtain for 6-m steel monopiles in the North Sea. During installation of monopiles (~8 m) for more than 150 WTGs in comparable water depths (> 25 m) and conditions in Europe indicate that attenuation of 10 dB is readily achieved (Bellmann, 2019; Bellmann *et al.*, 2020) using single BBCs for noise attenuation. Designed to gather additional data regarding the efficacy of BBCs, the Coastal Virginia Offshore Wind (CVOW) pilot project systematically measured noise resulting from the impact driven installation of two 7.8-m monopiles, one installation using a dBBC and the other installation using no noise abatement system (CVOW, unpublished data). Although many factors contributed to variability in received levels throughout the installation of the piles (*e.g.*, hammer energy, technical challenges during operation of the dBBC), reduction in broadband SEL using the dBBC (comparing measurements derived from the mitigated and the unmitigated monopiles) ranged from approximately 9-15 dB. Again, NMFS would require Revolution Wind to apply a dBBC, or a single BBC coupled with an additional noise mitigation device, to ensure sound generated from the project does not exceed that modeled (assuming 10-dB reduction) at given ranges to harassment isopleths, and to minimize noise levels to the lowest level practicable. Double BBCs are successfully and widely applied across European wind development efforts, and are known to reduce noise levels more than single BBC alone (*e.g.*, Bellman *et al.*, 2020). Revolution Wind anticipates, and NMFS agrees, that the use of a noise abatement system would likely produce field measurements of the isopleth distances to the Level A harassment and Level B harassment thresholds that accord with those modeled assuming 10-dB of attenuation for impact pile driving of monopiles (refer back to the **Estimated Take**, **Proposed Mitigation**, and **Proposed Monitoring and Reporting** sections).

Use of PSOs and PAM Operators

As described above, Revolution Wind would be required to use PSOs and acoustic PSOs (*i.e.*, PAM operators) during all foundation installation activities. At minimum, four PSOs would be actively observing marine mammals before, during, and after pile driving. At least two PSOs would be stationed on the pile driving vessel and at least two PSOs would be stationed on a secondary, dedicated PSO vessel. The dedicated PSO vessel would be located at the outer edge of the 2.3 km (in the summer; 4.4 km in the winter) large whale clearance zone (unless modified by NMFS based on SFV). Concurrently, at least one PAM operator would be actively monitoring for marine mammals before, during, and after pile driving. More details on PSO and PAM operator requirements can be found in the **Proposed Monitoring and Reporting** section.

Furthermore, all crew and personnel working on the Revolution Wind project would be required to maintain situational awareness of marine mammal presence (discussed further above) and would be required to report any sightings to the PSOs.

Clearance and Shutdown Zones

NMFS is proposing to require the establishment of both clearance and shutdown zones during all impact pile driving of WTG and OSS foundation piles, which would be monitored by visual PSOs and PAM operators before, during and after pile driving. Prior to the start of impact pile driving activities, Revolution Wind would clear the area of marine mammals, per the clearance zones in Table 34, to minimize the potential for and degree of harassment.

The purpose of "clearance" of a particular zone is to prevent potential instances of auditory injury and more severe behavioral disturbance or, in the case of North Atlantic right whales, avoid and minimize behavioral disturbance to the maximum extent practicable (for North Atlantic right whales, the clearance and shutdown zones are set to any distance; see Table 34) by delaying the commencement of impact pile driving if marine mammals are detected within certain pre-defined distances from the pile being installed.

PSOs would visually monitor for marine mammals for a minimum of 60 minutes immediately prior to commencement of pile driving, while PAM operators would review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes immediately prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be visually confirmed to be free of marine mammals for 30 minutes immediately prior to starting a soft-start of pile driving. If a marine mammal is observed entering or within the relevant clearance zone prior to the initiation of impact pile driving activities, pile driving must be delayed and will not begin until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred (*i.e.*, 15 minutes for small odontocetes and 30 minutes for all other marine mammal species).

Mitigation zones related to impact pile driving activities were created around two different seasonal periods in consideration of the different seasonal sound speed profiles that were used in JASCO's underwater sound propagation modeling, including summer (May through November) and winter (December) (Table 34). In addition to the clearance and shutdown zones that would be monitored both visually and acoustically, NMFS is proposing to establish a minimum visibility zone to ensure that marine mammals are visually detected prior to commencement of pile driving. The minimum visibility zone would extend 2,300 m from the pile during summer months and 4,400 m during December (Table 34). These values correspond to the maximum low-frequency cetacean (*i.e.*, baleen whale) distances to the Level A harassment isopleths assuming three monopiles are driven in a day, rounded up to the nearest hundred. The entire minimum visibility zone must be visible (*i.e.*, not obscured by dark, rain, fog, etc.) for a full 30 minutes immediately prior to commencing impact pile driving. For North Atlantic right whales, there is an additional requirement that the clearance zone may only be declared clear if no confirmed North Atlantic right whale acoustic detections (in addition to visual) have occurred during the 60-minute monitoring period. Any large whale sighted by a PSO or acoustically detected by a PAM operator that cannot be identified as a non-North Atlantic right whale must be treated as if it were a North Atlantic right whale.

The purpose of a shutdown is to prevent a specific acute impact, such as auditory injury or severe behavioral disturbance of sensitive species, by halting the activity. If a marine mammal is observed entering or within the respective shutdown zone (Table 34) after impact pile driving has begun, the PSO will request a temporary cessation of impact pile driving. In situations when shutdown is called for but Revolution Wind determines shutdown is not practicable due to imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals, reduced hammer energy must be implemented when the lead engineer determines it is practicable. Specifically, pile refusal or pile instability could result in not being able to shut down pile driving immediately. Pile refusal occurs when the pile driving sensors indicate the pile is approaching refusal, and a shut-down would lead to a stuck pile which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. Pile instability occurs when the pile is unstable and unable to stay standing if the piling vessel were to "let go." During these periods of instability, the lead engineer may determine a shutdown is not feasible because the shutdown combined with impending weather conditions may require the piling vessel to "let go" which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. In these situations, Revolution Wind must reduce hammer energy to the lowest level practicable.

After shutdown, impact pile driving may be reinitiated once all clearance zones are clear of marine mammals for the minimum species-specific periods (15 minutes for small odontocetes and 30 minutes for all other marine mammal species). If pile driving has been shut down due to the presence of a North Atlantic right whale, pile driving may not restart until the North Atlantic right whale is no longer observed or 30 minutes has elapsed since the last detection. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability, at which time Revolution Wind must use the lowest hammer energy practicable to maintain stability. Upon re-starting pile driving, soft start protocols must be followed.

The clearance and shutdown zone sizes vary by species and are shown in Table 34. All distances to the perimeter of clearance zones are the radii from the center of the pile. Pursuant to the proposed adaptive management provisions, Revolution Wind may request modification to these zone sizes pending results of sound field verification (see **Proposed Monitoring and Reporting** section). Any changes to zone size would require NMFS' approval.

Table 34. Clearance, Shutdown, Minimum Visibility, and Level B Harassment Zones During Impact Pile Driving In Summer And Winter[1]

Monitoring details	Zone Sizes for Impact Piling (m)									
	North Atlantic right whales		Large whales		Delphinids		Harbor porpoises		Seals	
Foundation Type	WTG	OSS	WTG	OSS	WTG	OSS	WTG	OSS	WTG	OSS
Clearance Zone	any distance		2,300 (4,400)	1,600 (2,700)	NAS[2]	NAS	1,400 (2,400)	900 (1,300)	500 (900)	400 (400)
PAM Clearance Zone	3,900 (4,300)	4,100 (4,700)	n/a							
Shutdown Zone	any distance		2,300 (4,400)	1,600 (2,700)	NAS	NAS	1,400 (2,400)	900 (1,300)	500 (900)	400 (400)
PAM Shutdown Zone	3,900 (4,400)	4,100 (4,700)	n/a							
Minimum Visibility Zone	WTG: 2,300 (4,400) OSS: 1,600 (2,700)									
Level B Harassment Zone	WTG: 3,833 (4,271) OSS: 4,100 (4,698)									

1 - Winter (i.e., December) distances are presented in parentheses.

2 - NAS (noise abatement system) means that the zone is small enough that it would be encompassed by the bubble curtain.

Soft-Start

The use of a soft start procedure is believed to provide additional protection to marine mammals by warning them, or providing them with a chance to leave the area prior to the hammer operating at full capacity. Soft start typically involves initiating hammer operation at a reduced energy level (relative to full operating capacity) followed by a waiting period. Revolution Wind must utilize a soft start protocol for impact pile driving of monopiles by performing 4-6 strikes per minute at 10 to 20 percent of the maximum hammer energy, for a minimum of 20 minutes. NMFS notes that it is difficult to specify a reduction in energy for any given hammer because of variation across drivers. For impact hammers, the actual number of strikes at reduced energy will vary because operating the hammer at less than full power results in “bouncing” of the hammer as it strikes the pile, resulting in multiple “strikes”; however, as mentioned previously, Revolution Wind will target less than 20 percent of the total hammer energy for the initial hammer strikes during soft start. Soft start will be required at the beginning of each day’s monopile installation, and at any time following a cessation of impact pile driving of 30 minutes or longer. If a marine mammal is detected within or about to enter the applicable clearance zones prior to the beginning of soft-start procedures, impact pile driving would be delayed until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings (*i.e.*, 15 minutes for small odontocetes and 30 minutes for all other species).

Cofferdam or Casing Pipe Installation and Removal

For cofferdam or casing pipe installation and removal, NMFS is proposing to include the following mitigation requirements, which are described in detail below: daily restrictions; the use of PSOs; the implementation of clearance and shutdown zones; and the use of soft-start if a pneumatic impact hammer is used. Given the short duration of work, relatively small harassment zones if a pneumatic hammer is used, and lower noise levels during vibratory driving, NMFS is not proposing to require PAM or noise abatement system use during these activities.

Seasonal and Daily Restrictions

Revolution Wind has proposed to construct the cofferdams or casing pipe scenario within the first year of the effective period of the regulations and LOA. NMFS is not requiring any seasonal work restrictions for landfall construction in this proposed rule due to the relatively short duration of work (*i.e.*, low associated impacts). Revolution Wind would be required, however, to conduct vibratory pile driving associated with cofferdam installation and pneumatic hammering of casing pipes during daylight hours only. Although North Atlantic right whales do migrate in coastal waters, they are not expected to occur in Narragansett Bay where work would be occurring. The distance to the Level B harassment isopleth (9.74 km) for installation of steel sheet piles and the maximum distance to the Level A isopleth (3.95 km) for installation of a casing pipe do not extend beyond the mouth of Narragansett Bay; thus, it is unlikely that right whales (or most species of marine mammals considered here) would be exposed to vibratory pile driving during cofferdam or goal post sheet pile installation at levels close to the 120 dB Level B harassment threshold, or pneumatic hammering at Level A harassment thresholds.

Use of PSOs

Prior to the start of vibratory pile driving or pneumatic hammering activities, at least two PSOs located at the best vantage points would monitor the clearance zone for 30 minutes, continue monitoring during pile driving or pneumatic hammering, and for 30 minutes following cessation of either activity. The clearance zones must be fully visible for at least 30 minutes and all marine mammal(s) must be confirmed to be outside of the clearance zone for at least 30 minutes immediately prior to initiation of either activity.

Clearance and Shutdown Zones

Revolution Wind would establish clearance and shutdown zones for vibratory pile driving activities associated with cofferdam installation (Table 35) and pneumatic hammering for casing pipe installation (Table 36). If a marine mammal is observed entering or is observed within the respective zones, activities will not commence until the animal has exited the zone or a specific amount of time has elapsed since the last sighting (*i.e.*, 30 minutes for large whales and 15 minutes for dolphins, porpoises, and pinnipeds). If a marine mammal is observed entering or within the respective shutdown zone after vibratory pile driving or pneumatic hammering has begun, the PSO will call for a temporary cessation of the activity. Pile driving or hammering must not be restarted until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred (*i.e.*, 15 minutes for small odontocetes and 30 minutes for all other marine mammal species). Because a vibratory hammer can grip a pile without operating, pile instability should not be a concern and no caveat for re-starting pile driving due to pile instability is proposed.

Table 35. Distances to Harassment Thresholds and Mitigation Zones During Vibratory Sheet Pile Driving

Marine Mammal Species	Level A harassment (SEL_{cum}) (m)	Level B harassment (m)	Clearance Zone (m)	Shutdown Zone (m)
Low-frequency cetaceans				
Fin whale*	5	9,740	100	100
Minke whale	5	9,740	100	100
Sei whale*	5	9,740	100	100
Humpback whale	5	9,740	100	100
North Atlantic right whale*	5	9,740	100	100
Blue whale*	5	9,740	100	100

Mid-frequency cetaceans				
Sperm whale*	-	9,740	100	100
Atlantic white-sided dolphin	-	9,740	50	50
Atlantic spotted dolphin	-	9,740	50	50
Common dolphin	-	9,740	50	50
Risso's dolphin	-	9,740	50	50
Bottlenose dolphin	-	9,740	50	50
Pilot whales	-	9,740	50	50
High-frequency cetaceans				
Harbor porpoise	190	9,740	200[1]	200[1]
Phocid Pinnipeds (in water)				
Gray seal	10	9,740	50	50
Harbor seal	10	9,740	50	50

** Denotes species listed under the Endangered Species Act*
1 - Distance has been increased from 100 m, as proposed by Revolution Wind, to ensure the clearance and shutdown zones are larger than the Level A harassment zone (190 m).

Table 36. Distances to Harassment Thresholds and Mitigation Zones During Casing Pipe Installation

Marine Mammal Hearing Group	Level A harassment (SEL_{cum}) (m)	Level B harassment (m)	Clearance Zone (m)	Shutdown Zone (m)
Low-frequency	3,870	920	3,900	3,900
Mid-frequency	230	920	250	250
High-frequency	3,950	920	4,000	4,000
Phocid pinnipeds	1,290	920	1,300	1,300

UXO/MEC Detonations

For UXO/MEC detonations, NMFS is proposing to include the following mitigation requirements, which are described in detail below: As Low as Reasonably Practical Approach (ALARP); seasonal and daily restrictions; the use of noise abatement systems; the use of PSOs and PAM operators to visually and acoustically monitor for marine mammals; and the implementation of clearance zones.

As Low as Reasonably Practicable (ALARP) Approach

For any UXOs/MECs that require removal, Revolution Wind would be required to implement the As Low as Reasonably Practicable (ALARP) process. This process would require Revolution Wind to undertake “life-and-shift” (*i.e.*, physical removal and then lead up to in situ disposal), which would include low-order (deflagration) to high-order (detonation) methods of removal. Another potential approach involve the cutting of the UXO/MEC to extract any explosive components. Implementing the ALARP approach would minimize potential impacts to marine mammals, as UXOs/MECs would only be detonated as a last resort.

Seasonal and Daily Restrictions

Revolution Wind would be limited to only detonating a total of 13 UXOs/MECs between May 1 and October 31 to reduce impacts to North Atlantic right whales during peak occurrence periods. Furthermore, UXO/MEC detonation would be limited to daylight hours only to ensure that visual PSOs can confirm appropriate clearance of the site prior to detonation events.

Noise Abatement Systems

Revolution Wind would be required to use a noise abatement system during all UXO/MEC detonations, should detonations be determined to be necessary. Although the exact level of noise attenuation that can be achieved by noise abatement systems is unknown, available data from Bellmann *et al.* (2020) and Bellmann and Betke (2021) provide a reasonable expectation that the noise abatement systems would be able to achieve at least 10-dB attenuation. SFV would be required for all detonation events to verify the modeled distances, assuming 10-dB attenuation, are representative of the sound fields generated during detonations. This level of noise reduction would provide substantial reductions in impact zones for low-frequency cetaceans such as the North Atlantic right whale. For example, assuming the largest UXO/MEC charge weight (454 kg; E12) at a depth of 45 m, 10-dB of attenuation reduces the Level A harassment (PTS) zone from 243 km^2 to approximately 45 km^2 (Table 45 in the ITA application). The Level B harassment zone, given the same parameters, would be decreased from 1,158 km^2 to 445 km^2 (Table 47 in the ITA application). However, and as previously stated in this notice, Revolution Wind does not expect that all 13 of the potential UXOs/MECs would be of the largest charge weight; this weight was used as a conservative option in estimating exposures and take of marine mammals.

Use of PSOs and PAM Operators

Prior to the UXO/MEC detonation, at least two PSOs per observing platform (*i.e.*, vessels, plane) located at the best vantage points would monitor the clearance zone for 60 minutes, continue monitoring during the detonation, and for 30 minutes following the event. The clearance zones must be fully visible for at least 60 minutes and all marine mammal(s) must be confirmed to be outside of the clearance zone for at least 30 minutes immediately prior to initiation of either activity. PAM must also be conducted for at least 60 minutes prior to detonation and the zone must be acoustically clear during this time.

Clearance Zones

Revolution Wind proposed to clear a 3.78-km radius zone around the detonation site prior to detonations using both visual and acoustic monitoring methods. This distance represents the modeled Level A (PTS) harassment zone for low-frequency cetaceans (*i.e.*, large whales) assuming the largest 454-kg charge weight and use of a bubble curtain (Table 37). However, NMFS is proposing to require more protective zone sizes in order to ensure the least practicable adverse impact, which includes minimizing the potential for TTS. As stated above, it is currently not known how easily Revolution Wind will be able to identify UXO/MEC charge weights in the field. For this reason, NMFS proposes to require Revolution Wind to clear a zone extending 10 km for large whales, 2 km for delphinids, 10 km for harbor porpoises, and 5 km for seals (Table 37). These zones are based on (but not equal to) the largest TTS threshold distances for a 454-kg charge at any site modeled. However, NMFS notes that these zone sizes may be adjusted based on SFV and confirmation of UXO/MEC/doner charge sizes. Moreover, if Revolution Wind indicates to NMFS they will be able to easily and reliably identify charge weights in the field, NMFS would develop clearance zones in the final rule for each charge weight analyzed.

If a marine mammal is observed entering or within the clearance zone prior to denotation, the activity would be delayed. Only when the marine mammals have been confirmed to have voluntarily left the clearance zones and been visually confirmed to be beyond the clearance zone, or when 60 minutes have elapsed without any redetections for whales (including the North Atlantic right whale) or 30 minutes have elapsed without any redetections of delphinids, harbor porpoises, or seals may detonation occur.

Table 37. Largest Modeled Harassment and Clearance Zones for UXO/MEC Detonation of E12 (454 kg) Charge Assuming 10-dB Noise Abatement

Marine Mammal Species	Distances to Zones for E12 (454 kg) UXO/MEC Charge Weight[1]		
	Level A Harassment Clearance Zone (m)	Level B Harassment Zone (m)	Clearance Zones
Low-frequency cetaceans			
Fin whale*	3,780	11,900	10,000
Minke whale			
Sei whale*			
Humpback whale			

North Atlantic right whale*			
Blue whale*			
Mid-frequency cetaceans			
Sperm whale*	461	2,550	2,000
Atlantic white-sided dolphin			
Atlantic spotted dolphin			
Common dolphin			
Risso's dolphin			
Bottlenose dolphin			
Long-finned pilot whale			
High-frequency cetaceans			
Harbor porpoise	6,200	14,100	10,000
Pinnipeds (in water)			
Gray seal	1,600	6,990	5,000
Harbor seal			

** Denotes species listed under the Endangered Species Act*
1 - At time of preparing this proposed rule, Revolution Wind has not provided NMFS evidence they will be able to reliably determine the charge weight of any UXO/MEC that must be detonated; therefore, NMFS assumes all UXO/MECs could be of the largest size modeled. If Revolution Wind provides information they can detect charge weights in the field prior to issuance of the final rule, if issued, NMFS may modify the clearance zone to ones based on charge weights distances to PTS and TTS. Distances to PTS and TTS thresholds have been identified by Revolution Wind in Appendix B of their application.

HRG Surveys

For HRG surveys, NMFS is proposing to include the following mitigation requirements, which are described in detail below, for all HRG survey activities using boomers, sparkers, and CHIRPs: the use of PSOs; the implementation of clearance, shutdown, and vessel separation zones; and ramp-up of survey equipment.

There are no mitigation measures prescribed for sound sources operating at frequencies greater than 180 kHz, as these would be expected to fall outside of marine mammal hearing ranges and not result in harassment; however, all HRG survey vessels would be subject to the aforementioned vessel strike avoidance measures described earlier in this section. Furthermore, due to the frequency range and characteristics of some of the sound sources, shutdown, clearance, and ramp-up procedures are not proposed to be conducted during HRG surveys utilizing only non-impulsive sources (*e.g.*, Ultra-Short BaseLine (USBL) and other parametric sub-bottom profilers), with exception to usage of CHIRPS and other non-parametric sub-bottom profilers. PAM would not be required during HRG surveys. While NMFS agrees that PAM can be an important tool for augmenting detection capabilities in certain circumstances, its utility in further reducing impacts during HRG survey activities is limited. We have provided a thorough description of our reasoning for not requiring PAM during HRG surveys in several **Federal Register** notices (*e.g.*, 87 FR 40796, July 8, 2022; 87 FR 52913, August 3, 2022; 87 FR 51356, August 22, 2022).

Seasonal and Daily Restrictions

Given the potential impacts to marine mammals from exposure to HRG survey noise sources are relatively minor (*e.g.*, limited to Level B harassment) and that the distances to the Level B harassment isopleth is very small (maximum distance is 141 m), NMFS is not proposing to implement any seasonal or time-of-day restrictions for HRG surveys.

Although no temporal restrictions are proposed, NMFS would require Revolution Wind to deactivate acoustic sources during periods where no data is being collected, except as determined necessary for testing. Any unnecessary use of the acoustic source would be avoided.

Use of PSOs

During all HRG survey activities using boomers, sparkers, and CHIRPS, one PSO would be required to monitor during daylight hours and two would be required to monitor during nighttime hours, per vessel. PSOs would begin visually monitoring 30 minutes prior to the initiation of the specified acoustic source (*i.e.*, ramp-up, if applicable) through 30 minutes after the use of the specified acoustic source has ceased. PSOs would be required to monitor the appropriate clearance and shutdown zones. These zones would be based around the radial distance from the acoustic source and not from the vessel.

Clearance, Shutdown, and Vessel Separation Zones

Revolution Wind would be required to implement a 30-minute clearance period of the clearance zones (Table 38) immediately prior to the commencing of the survey, or when there is more than a 30-minute break in survey activities and PSOs have not been actively monitoring. The clearance zones would be monitored by PSOs, using the appropriate visual technology. If a marine mammal is observed within a clearance zone during the clearance period, ramp-up (described below) may not begin until the animal(s) has been observed voluntarily exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (*i.e.*, 15 minutes for small odontocetes and seals, and 30 minutes for all other species). In any case when the clearance process has begun in conditions with good visibility, including via the use of night vision equipment (IR/thermal camera), and the Lead PSO has determined that the clearance zones are clear of marine mammals, survey operations would be allowed to commence (*i.e.*, no delay is required) despite periods of inclement weather and/or loss of daylight.

Once the survey has commenced, Revolution Wind would be required to shut down boomers, sparkers, and CHIRPs if a marine mammal enters a respective shutdown zone (Table 38). In cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.*, no shutdown is required) so long as no marine mammals have been detected. The use of boomers, sparkers, and CHIRPS would not be allowed to commence or resume until the animal(s) has been confirmed to have left the shutdown zone or until a full 15 minutes (for small odontocetes and seals) or 30 minutes (for all other marine mammals) have elapsed with no further sighting. Any large whale sighted by a PSO within 1,000 m of the boomers, sparkers, and CHIRPs that cannot be identified as a non-North Atlantic right whale would be treated as if it were a North Atlantic right whale.

The shutdown requirement would be waived for small delphinids of the following genera: *Delphinus*, *Stenella*, *Lagenorhynchus,* and *Tursiops*. Specifically, if a delphinid from the specified genera is visually detected approaching the vessel (*i.e.*, to bow-ride) or towed equipment, shutdown would not be required. Furthermore, if there is uncertainty regarding identification of a marine mammal species (*i.e.*, whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived), the PSOs would use their best professional judgment in making the decision to call for a shutdown. Shutdown would be required if a delphinid that belongs to a genus other than those specified is detected in the shutdown zone.

If a boomer, sparker, or CHIRP is shut down for reasons other than mitigation (*e.g.*, mechanical difficulty) for less than 30 minutes, it would be allowed to be activated again without ramp-up only if (1) PSOs have maintained constant observation, and (2) no additional detections of any marine mammal occurred within the respective shutdown zones. If a boomer, sparker, or CHIRP was shut down for a period longer than 30 minutes, then all clearance and ramp-up procedures would be required, as previously described.

Table 38. Harassment Threshold Ranges and Mitigation Zones During HRG Surveys

Marine Mammal Species	Level B Harassment Zone (m)		Clearance Zone (m)	Shutdown Zone (m)
	Boomer/Sparker	CHIRPs		
Low-frequency cetaceans				
Fin whale*	141	48	100	100

Minke whale			100	100
Sei whale*			100	100
Humpback whale			100	100
North Atlantic right whale*			500	500
Blue whale*			100	100
Mid-frequency cetaceans				
Sperm whale*	141	48	100	100
Atlantic white-sided dolphin			100	n/a
Atlantic spotted dolphin			100	n/a
Common dolphin			100	n/a
Risso's dolphin			100	100
Bottlenose dolphin			100	n/a
Long-finned pilot whale			100	100
High-frequency cetaceans				
Harbor porpoise	141	48	100	100
Phocid Pinnipeds (in water)				
Gray seal	141	48	100	100
Harbor seal				

Note: n/a = no shutdown zone mitigation will be applied as these species are known to bow-ride.
** Denotes species is listed under the Endangered Species Act*

Ramp-Up

At the start or restart of the use of boomers, sparkers, and/or CHIRPs, a ramp-up procedure would be required unless the equipment operates on a binary on/off switch. A ramp-up procedure, involving a gradual increase in source level output, is required at all times as part of the activation of the acoustic source when technically feasible. Operators would ramp up sources to half power for 5 minutes and then proceed to full power. Prior to a ramp-up procedure starting, the operator would have to notify the Lead PSO of the planned start of the ramp-up. This notification time would not be less than 60 minutes prior to the planned ramp-up activities as all relevant PSOs would need the appropriate 30 minute period to monitor prior to the initiation of ramp-up. Prior to ramp-up beginning, the operator must receive confirmation from the PSO that the clearance zone is clear of any marine mammals. All ramp-ups would be scheduled to minimize the overall time spent with the source being activated. The ramp-up procedure must be used at the beginning of HRG survey activities or after more than a 30-minute break in survey activities using the specified HRG equipment to provide additional protection to marine mammals in or near the survey area by allowing them to vacate the area prior to operation of survey equipment at full power.

Revolution Wind would not initiate ramp-up until the clearance process has been completed (see Clearance and Shutdown Zones section above). Ramp-up activities would be delayed if a marine mammal(s) enters its respective clearance zone. Ramp-up would only be reinitiated if the animal(s) has been observed exiting its respective shutdown zone or until additional time has elapsed with no further sighting (*i.e.*, 15 minutes for small odontocetes and seals, and 30 minutes for all other species).

ASV use

Should Revolution Wind use an ASV for HRG survey operations, the following measures would be implemented:

- When in use, the ASV would be within 800 m (2,625 ft) of the primary vessel while conducting survey operations;
- Two PSOs would be stationed aboard the mother vessel at the best vantage points to monitor the clearance and shutdown zones around the ASV;
- A dual thermal/high definition camera would be installed on the mother vessel, facing forward and angled in a direction to provide a field of view ahead of the vessel and around the ASV. PSOs would monitor the real-time camera output on hand-held tablets. A monitor would also be installed on the bridge, displaying the real-time image from the thermal/HD camera installed on the ASV itself, providing an additional forward field of view from the ASV;
- Night-vision goggles with thermal clip-ons, and a hand-held spotlight would be used to monitor the ASV during survey operations during periods of reduced visibility (*e.g.*, darkness, rain, fog).

Fishery Monitoring Surveys

Training

All crew undertaking the fishery survey activities would be required to receive protected species identification training prior to activities occurring. Marine mammal monitoring must occur prior to, during, and after haul-back, and gear must not be deployed if a marine mammal is observed in the area. Trawl operations must only start after 15 minutes of no marine mammal sightings within 1 nm of the sampling station.

Gear-specific Best Management Practices (BMPs)

During daytime sampling for the research trawl surveys, Revolution Wind must maintain visual monitoring efforts during the entire period of time that trawl gear is in the water from deployment to retrieval. If a marine mammal is sighted before the gear is removed from the water, the vessel must slow its speed and steer away from the observed animal(s).

Revolution Wind would be required to undertake BMPs to reduce risks to marine mammals during trawl and trap surveys. These include:

- For research trawls, these specifically include limiting tow time to 20 minutes and monitoring for marine mammals throughout gear deployment, fishing, and retrieval. For ventless trap surveys, these include the breaking strength of all lines being less than 1,700 pounds, the use of sinking line for groundlines, the hauling of sampling gear at least once every 30 days, and the removal of gear at the end of each sampling season;
- The permit number would be written clearly on buoy and any lines that go missing would be reported to NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO) Protected Resources Division as soon as possible;
- If marine mammals are sighted near the proposed sampling location, deployment of research trawl nets and ventless traps would be delayed until the marine mammal(s) has left the area;
- If a marine mammal is determined to be at risk of interaction with the deployed gear, all gear would be immediately removed; and
- If marine mammals are sighted in the vicinity within 15 minutes prior to gear deployment and it is determined the risks of interaction are present regarding the research gear, the sampling station would either move to another location or suspend activities until there are no marine mammal sightings for 15 minutes within 1 nm.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures would provide the means of affecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to promulgate a rulemaking for an activity, section 101(a)(5)(A) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.*, presence, abundance, distribution, density);
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (*e.g.*, source characterization, propagation, ambient noise); (2) affected species (*e.g.*, life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.*, age, calving or feeding areas);

- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.*, marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and/or
- Mitigation and monitoring effectiveness.

Separately, monitoring is also regularly used to support mitigation implementation, which is referred to as mitigation monitoring, and monitoring plans typically include measures that both support mitigation implementation and increase our understanding of the impacts of the activity on marine mammals.

During Revolution Wind's construction activities, visual monitoring by NMFS-approved PSOs would be conducted before, during, and after impact pile driving, vibratory pile driving and pneumatic hammering, any UXO/MEC detonations, and HRG surveys. PAM would also be conducted during all impact pile driving and UXO/MEC detonations. Observations and acoustic detections by PSOs would be used to support the activity-specific mitigation measures described above. Also, to increase understanding of the impacts of the activity on marine mammals, observers would record all incidents of marine mammal occurrence at any distance from the piling and pneumatic hammering locations, UXO/MEC detonation site, and during active HRG acoustic sources, and monitors would document all behaviors and behavioral changes, in concert with distance from an acoustic source. The required monitoring is described below, beginning with

PSO measures that are applicable to all activities or monitoring, followed by activity-specific monitoring requirements.

Protected Species Observer Requirements

Revolution Wind would be required to collect sighting data and behavioral response data related to construction activities for marine mammal species observed in the region of the activity during the period in which the activities occur using NMFS-approved visual and acoustic PSOs (see **Proposed Mitigation** section). All observers must be trained in marine mammal identification and behaviors, and are required to have no other construction-related tasks while conducting monitoring. PSOs would monitor all clearance and shutdown zones prior to, during, and following impact pile driving, vibratory pile driving, pneumatic hammering, UXO/MEC detonation, and during HRG surveys using boomers, sparkers, and CHIRPs (with monitoring durations specified further below). Any PSO would have the authority to call for a delay or shutdown of survey activities. PSOs will also monitor the Level B harassment zones and will document any marine mammals observed within these zones, to the extent practicable (noting that some zones are too large to fully observe). Observers would be located at the best practicable vantage points on the pile driving vessel and, where required, on an aerial platform. Full details regarding all marine mammal monitoring must be included in relevant Plans (*e.g.*, Pile Driving and Marine Mammal Monitoring Plan) that, under this proposed action, Revolution Wind would be required to submit to NMFS for approval at least 180 days in advance of the commencement of any construction activities.

The following measures apply to all visual monitoring efforts:

1. Monitoring must be conducted by NMFS-approved, trained PSOs who would be placed at the primary location relevant to the activity (*i.e.*, pile driving vessel, pneumatic hammering location, UXO/MEC vessel, HRG survey vessel), dedicated PSO vessels (*e.g.*, additional UXO/MEC vessel(s) when the

detonation area is larger than 2 km), and aerial survey plane and must be in positions that allow for the best vantage point to monitor for marine mammals and implement the relevant clearance and shutdown procedures, when determined to be applicable;

2. PSO must be independent third-party observers and must have no tasks other than to conduct observational effort, collect data, and communicate with and instruct the relevant vessel crew with regard to the presence of protected species and mitigation requirements;

3. During all observation periods related to pile driving (impact and vibratory), pneumatic hammering, UXO/MEC detonations, and HRG surveys, PSOs would be located at the best vantage point(s) in order to ensure 360° visual coverage of the entire clearance and shutdown zones around the observing platform and as much of the Level B harassment zone as possible, while still maintaining a safe work environment;

4. PSOs may not exceed 4 consecutive watch hours, must have a minimum 2-hour break between watches, and may not exceed a combined watch schedule of more than 12 hours in a single 24-hour period;

5. PSOs would be required to use appropriate equipment (specified below) to monitor for marine mammals. During periods of low visibility (*e.g.*, darkness, rain, fog, poor weather conditions, etc.), PSOs would be required to use alternative technologies (*i.e.*, infrared or thermal cameras) to monitor the shutdown and clearance zones.

6. PSOs should have the following minimum qualifications:

a. Visual acuity in both eyes (corrected is permissible) sufficient for discernment of moving targets at the water's surface with the ability to estimate the target size and distance. The use of binoculars is permitted and may be necessary to correctly identify the target(s);

b. Ability to conduct field observations and collect data according to the assigned protocols;

c. Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations;

d. Writing skills sufficient to document observations, including but not limited to: the number and species of marine mammals observed, the dates and times of when in-water construction activities were conducted, the dates and time when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone, and marine mammal behavior.

e. Ability to communicate orally, by radio, or in-person, with project personnel to provide real-time information on marine mammals observed in the area, as necessary.

Observer teams employed by Revolution Wind, in satisfaction of the mitigation and monitoring requirements described herein, must meet the following additional requirements:

7. At least one observer must have prior experience working as an observer.

8. Other observers may substitute education (a degree in biological science or a related field) or training for experience;

9. One observer will be designated as lead observer or monitoring coordinator (“Lead PSO”). This Lead PSO would be required to have a minimum

of 90 days of at-sea experience working in this role in an offshore environment, and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience;

10. At least one PSO located on platforms (either vessel-based or aerial) would be required to have a minimum of 90 days of at-sea experience working in this role in an offshore environment and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience; and

11. All PSOs must be approved by NMFS. Revolution Wind would be required to submit resumes of the initial set of PSOs necessary to commence the project to NMFS Office of Protected Resources (OPR) (at *itp.esch@noaa.gov*) for approval at least 60 days prior to the first day of in-water construction activities requiring PSOs. Resumes would need to include the dates of training and any prior NMFS approval, as well as the dates and description of their last PSO experience, and must be accompanied by information documenting their successful completion of an acceptable training course. NMFS would allow three weeks to approve PSOs from the time that the necessary information is received by NMFS, after which any PSOs that meet the minimum requirements would automatically be considered approved.

Some activities planned to be undertaken by Revolution Wind may require the use of PAM, which would necessitate the employment of at least one acoustic PSO (aka PAM operator) on duty at any given time. PAM operators would be required to meet several of the specified requirements described above for PSOs, including: 2, 4, 6b-e, 8, 9, 10, and 11. Furthermore, PAM operators would be required to complete a specialized training for operating PAM systems and must demonstrate familiarity with the PAM system on which they would be working.

PSOs would be able to act as both acoustic and visual observers for the project if the individual(s) demonstrates that they have had the required level and appropriate training and experience to perform each task. However, a single individual would not be allowed to concurrently act in both roles or exceed work hours specified in #4 above.

Revolution Wind's personnel and PSOs would also be required to use available sources of information on North Atlantic right whale presence to aid in monitoring efforts. This includes:

1. Daily monitoring of the Right Whale Sightings Advisory System;
2. Consulting of the WhaleAlert app; and,
3. Monitoring of the Coast Guard's VHF Channel 16 throughout the day to receive notifications of any sightings and information associated with any Dynamic Management Areas, to plan construction activities and vessel routes, if practicable, to minimize the potential for co-occurrence with North Atlantic right whales.

Additionally, whenever multiple project-associated vessels (of any size; *e.g.*, construction survey, crew transfer) are operating concurrently, any visual observations of ESA-listed marine mammals must be communicated to PSOs and vessel captains associated with other vessels to increase situational awareness.

The following are proposed monitoring and reporting measures that NMFS would require specific to each construction activity:

WTG and OSS Foundation Installation

Revolution Wind would be required to implement the following monitoring procedures during all impact pile driving activities of monopiles related to WTG and OSS installation.

During all observations associated with impact pile driving, PSOs would use high magnification (7x) binoculars and the naked eye to search continuously for marine mammals. At least one PSO on the foundation pile driving vessel and secondary dedicated-PSO vessel must be equipped with Big Eye binoculars (*e.g.*, 25 x 50; 2,7 view angle; individual ocular focus; height control) of appropriate quality. These would be pedestal-mounted on the deck at the most appropriate vantage point that provides optimal sea surface observation and PSO safety.

Revolution Wind would be required to have a minimum of four PSOs actively observing marine mammals before, during, and after (specific times described below) the installation of foundation piles (monopiles). At least two PSOs must be actively observing on the pile driving vessel while at least two PSOs are actively observing on a secondary, PSO-dedicated vessel. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals before, during and after impact pile driving.

As described in the **Proposed Mitigation** section, if the minimum visibility zone cannot be visually monitored at all times, pile driving operations may not commence or, if active, must shutdown, unless Revolution Wind determines shutdown is not practicable due to imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals.

To supplement visual observation efforts, Revolution Wind would utilize at least one PAM operator before, during, and after pile installation. This PAM operator would assist the PSOs in ensuring full coverage of the clearance and shutdown zones. All on-duty visual PSOs would remain in contact with the on-duty PAM operator, who would monitor the PAM systems for acoustic detections of marine mammals in the area. In some cases, the PAM operator and workstation may be located onshore or they may be located on a vessel. In either situation, PAM operators would maintain constant and clear communication with visual PSOs on duty regarding detections of marine mammals that are approaching or within the applicable zones related to impact pile driving. Revolution

Wind would utilize PAM to acoustically monitor the clearance and shutdown zones (and beyond for situational awareness), and would record all detections of marine mammals and estimated distance, when possible, to the activity (noting whether they are in the Level A harassment or Level B harassment zones). To effectively utilize PAM, Revolution Wind would implement the following protocols:

- PAM operators would be stationed on at least one of the dedicated monitoring vessels in addition to the PSOs, or located remotely/onshore.
- PAM operators would have completed specialized training for operating PAM systems prior to the start of monitoring activities, including identification of species-specific mysticete vocalizations (*e.g.*, North Atlantic right whales).
- The PAM operator(s) on-duty would monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.
- Any detections would be conveyed to the PSO team and any PSO sightings would be conveyed to the PAM operator for awareness purposes, and to identify if mitigation is to be triggered.
- For real-time PAM systems, at least one PAM operator would be designated to monitor each system by viewing data or data products that are streamed in real-time or near real-time to a computer workstation and monitor located on a project vessel or onshore.
- The PAM operator would inform the Lead PSO on duty of marine mammal detections approaching or within applicable ranges of interest to the pile driving activity via the data collection software system (*i.e.*, Mysticetus or similar system), who would be responsible for

requesting that the designated crewmember implement the necessary mitigation procedures (*i.e.*, delay or shutdown).

- Acoustic monitoring during nighttime and low visibility conditions during the day would complement visual monitoring (*e.g.*, PSOs and thermal cameras) and would cover an area of at least the Level B harassment zone around each foundation.

All PSOs and PAM operators would be required to begin monitoring 60 minutes prior to any impact pile driving, during, and after for 30 minutes. However, PAM operators must review acoustic data from the previous 24 hours as well. As described in the **Proposed Mitigation** section, impact pile driving of monopiles would only commence when the minimum visibility zone (extending 2.3 km from the pile during summer months and 4.4 km during December for WTG foundation installations, and 1.6 km during summer months and 2.7 km during December for OSS foundation installations) is fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and the clearance zones are clear of marine mammals for at least 30 minutes, as determined by the Lead PSO, immediately prior to the initiation of impact pile driving.

For North Atlantic right whales, any visual (regardless of distance) or acoustic detection would trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be confirmed as a non-North Atlantic right whale species, it must be treated as if it were a North Atlantic right whale. Following a shutdown, monopile installation may not recommence until the minimum visibility zone is fully visible and the clearance zone is clear of marine mammals for 30 minutes and no marine mammals have been detected acoustically within the PAM clearance zone for 30 minutes.

Revolution Wind must prepare and submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any pile driving. The plans must include final pile driving project design (*e.g.*, number and type of piles, hammer type, noise abatement systems, anticipated start date, etc.) and all information related to PAM PSO monitoring protocols for pile-driving and visual PSO protocols for all activities.

Cofferdam or Casing Pipe Installation and Removal

Revolution Wind would be required to implement the following procedures during all vibratory pile driving activities associated with cofferdam installation and removal, and pneumatic hammering installation and removal of casing pipes.

During all observation periods related to vibratory pile driving or pneumatic hammering, PSOs must use high-magnification (25x), standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals.

Revolution Wind would be required to have a minimum of two PSOs on active duty during any installation and removal of the temporary cofferdams, or casing pipes and goal post sheet piles. These PSOs would always be located at the best vantage point(s) on the vibratory pile driving or pneumatic hammering platform or secondary platform in the immediate vicinity of the primary platforms, in order to ensure that appropriate visual coverage is available of the entire visual clearance zone and as much of the Level B harassment zone as possible. NMFS would not require the use of PAM for these activities.

PSOs would monitor the clearance zone for the presence of marine mammals for 30 minutes before, throughout the installation of the sheet piles or casing pipes, and for 30 minutes after the activities have ceased. Sheet pile or casing pipe installation may only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of impact or vibratory pile driving.

UXO/MEC Detonations

Revolution Wind would be required to implement the following procedures during all UXO/MEC detonations.

During all observation periods related to UXO/MEC detonation, PSOs must use high-magnification (25x), standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. PSOs located on the UXO/MEC monitoring vessel((s) would also be equipped with “Big Eye” binoculars (*e.g.*, 25 x 150; 2.7 view angle; individual ocular focus; height control). These would be mounted on a pedestal on the deck of the vessel(s) at the most appropriate vantage to provide for optimal sea surface observation, as well as safety of the PSOs.

For detonation zones (based on UXO/MEC charge weight) larger than 2 km, a secondary vessel would be used for marine mammal monitoring. In the event a secondary vessel is needed, two PSOs would be located at an appropriate vantage point on this vessel and would maintain watch during the same time period as the PSOs on the primary monitoring vessel. For detonation zones larger than 5 km, Revolution Wind would also be required to perform an aerial survey. At least two PSOs must be deployed on the plane during the aerial survey that would occur before, during, and after UXO/detonation events. Revolution Wind would be required to ensure that the clearance zones are fully (100 percent) monitored prior to, during, and after detonations.

As UXO/MEC detonation would only occur during daylight hours, PSOs would only need to monitor during the period between civil twilight rise and set. All PSOs and PAM operators would be required to begin monitoring 60 minutes prior to the UXO/MEC detonation event, during the event, and after for 30 minutes. Detonation may only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to detonation.

The PAM operator(s) would be stationed on one of the dedicated monitoring vessels, but may also potentially be located remotely onshore, although the latter alternative is subject to approval by NMFS. When real-time PAM is used, at least one PAM operator would be designated to monitor each system by viewing the data or data products that would be streamed in real-time or near real-time to a computer workstation and monitor, which would be located either on an Revolution Wind vessel or onshore. The PAM operator would work in coordination with the visual PSOs to ensure the clearance zone is clear of marine mammals (both visually and acoustically) prior to the detonation. The PAM operator would inform the Lead PSO on-duty of any marine mammal detections approaching or within the clearance zones via the data collection software (*i.e.*, Mysticetus or a similar system), who would then be responsible for requesting the necessary mitigation procedure (*i.e.*, delay). The PAM operator would monitor the clearance zone for large whales, and beyond the zone as possible (dependent on the detection radius of the PAM monitoring equipment).

Revolution Wind must prepare and submit a UXO/MEC and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any UXO/MEC. The plans must include final project design and all information related to visual and PAM PSO monitoring protocols for UXO/MEC detonations.

HRG Surveys

Revolution Wind would be required to implement the following procedures during all HRG surveys.

During all observation periods, PSOs must use standard handheld (7x) binoculars and the naked eye to search continuously for marine mammals.

Between four and six PSOs would be present on every 24-hour survey vessel, and two to three PSOs would be present on every 12-hour survey vessel. Revolution Wind would be required to have at least one PSO on active duty during HRG surveys that are conducted during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset) and at least two PSOs during HRG surveys that are conducted during nighttime hours.

All PSOs would begin monitoring 30 minutes prior to the activation of boomers, sparkers, or CHIRPs; throughout use of these acoustic sources, and for 30 minutes after the use of the acoustic sources has ceased.

Given that multiple HRG vessels may be operating concurrently, any observations of marine mammals would be required to be communicated to PSOs on all nearby survey vessels.

Ramp-up of boomers, sparkers, and CHIRPs would only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of survey activities utilizing the specified acoustic sources.

During daylight hours when survey equipment is not operating, Revolution Wind would ensure that visual PSOs conduct, as rotation schedules allow, observations for comparison of sighting rates and behavior with and without use of the specified acoustic sources. Off-effort PSO monitoring must be reflected in the monthly PSO monitoring reports.

Marine Mammal Passive Acoustic Monitoring

As described previously, Revolution Wind would be required to utilize a PAM system to supplement visual monitoring for all monopile installations, as well as during all UXO/MEC detonations. PAM operators may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches. Again, PSOs can act as PAM operators or visual PSOs (but not simultaneously) as long as they demonstrate that their training and experience are sufficient to perform each task.

The PAM system must be monitored by a minimum of one PAM operator beginning at least 60 minutes prior to soft start of impact pile driving of monopiles and UXO/MEC detonation, at all times during monopile installation and UXO/MEC detonation, and 30 minutes post-completion of both activities. PAM operators must immediately communicate all detections of marine mammals at any distance (*i.e.*, not limited to the Level B harassment zones) to visual PSOs, including any determination regarding species identification, distance, and bearing and the degree of confidence in the determination.

PAM systems may be used for real-time mitigation monitoring. The requirement for real-time detection and localization limits the types of PAM technologies that can be used to those systems that are either cabled, satellite, or radio-linked. It is most likely that Revolution Wind would deploy autonomous or moored-remote PAM devices, including sonobuoy arrays or similar retrievable buoy systems. The system chosen will dictate the design and protocols of the PAM operations. Revolution Wind is not considering seafloor cabled PAM systems, in part due to high installation and maintenance costs, environmental issues related to cable laying, and the associated permitting complexities. For a review of the PAM systems Revolution Wind is considering, please see Appendix 4 of the Protected Species Mitigation and Monitoring Plan included in Revolution Wind's ITA application.

Towed PAM systems may be utilized for the Revolution Wind project only if additional PAM systems are necessary. Towed systems consist of cabled hydrophone arrays that would be deployed from a vessel and then typically monitored from the tow vessel. Notably, several challenges exist when using a towed PAM system (*i.e.*, the tow vessel may not be fit for the purpose as it may be towing other equipment, operating sound sources, or working in patterns not conducive to effective PAM). Furthermore, detection and localization capabilities for low-frequency cetacean calls (*i.e.*, mysticete species) can be difficult in a commercial deployment setting. Alternatively, these systems have many advantages, as they are often low cost to operate, have high mobility, and are fairly easy and reliable to operate. These types of systems also work well in conjunction with visual monitoring efforts.

Revolution Wind plans to deploy PAM arrays specific for mitigation and monitoring of marine mammals outside of the shutdown zone to optimize the PAM system's capabilities to monitor for the presence of animals potentially entering these zones. The exact configuration and number of PAM devices would depend on the size of the zone(s) being monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored. More closely spaced hydrophones would allow for more directionality and, perhaps, range to the vocalizing marine mammals; however, this approach would add additional costs and greater levels of complexity to the project. Mysticetes, which would produce relatively loud and lower-frequency vocalizations, may be able to be heard with fewer hydrophones spaced at greater distances. However, detecting smaller cetaceans (such as mid-frequency delphinids; odontocetes) may necessitate that more hydrophones be spaced closer together given the shorter propagation range of the shorter, mid-frequency acoustic signals (*e.g.*, whistles and echolocation clicks). As there are no "perfect fit" single optimal array configurations, these set-ups would need to be considered on a case-by-case basis.

A Passive Acoustic Monitoring (PAM) Plan must be submitted to NMFS for review and approval at least 180 days prior to the planned start of monopile installations. PAM should follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind (Van Parijs *et al.*, 2021). The plan must describe all proposed PAM equipment, procedures, and protocols. However, NMFS considers PAM usage for every project on a case-by-case basis, and would continue discussions with Revolution Wind regarding selection of the PAM system that is most appropriate for the proposed project. The authorization to take marine mammals would be contingent upon NMFS' approval of the PAM Plan.

Acoustic Monitoring for Sound Field and Harassment Isopleth Verification (SFV)

During the installation of the first three monopile foundations, and during all UXO/MEC detonations, Revolution Wind must empirically determine source levels, the ranges to the isopleths corresponding to the Level A harassment and Level B harassment thresholds, and the transmission loss coefficient(s). Revolution Wind may also estimate ranges to the Level A harassment and Level B harassment isopleths by extrapolating from in situ measurements conducted at several distances from the monopile being driven, and UXO/MEC being detonated. Revolution Wind must measure received levels at a standard distance of 750 m from the monopiles and at both the presumed modeled Level A harassment and Level B harassment isopleth ranges, or an alternative distance(s) as agreed to in the SFV Plan.

If acoustic field measurements collected during for installation of the first or subsequent monopile, and UXOs/MEC being detonated, indicate ranges to the isopleths corresponding to Level A harassment and Level B harassment thresholds are greater than the ranges predicted by modeling (assuming 10-dB attenuation), Revolution Wind must implement additional noise mitigation measures prior to installing the next monopile, or detonating any additional UXOs/MECs. Initial additional measures may include improving the efficacy of the implemented noise mitigation technology (*e.g.*, BBC, DBBC) and/or modifying the piling schedule to reduce the sound source. Each sequential modification would be evaluated empirically by acoustic field measurements. In the event that field measurements indicate ranges to isopleths corresponding to Level A harassment and Level B harassment thresholds are greater than the ranges predicted by modeling (assuming 10-dB attenuation), NMFS may expand the relevant harassment, clearance, and shutdown zones and associated monitoring protocols. If harassment zones are expanded beyond an additional 1,500 m, additional PSOs would be deployed on additional platforms, with each observer responsible for maintaining watch in no more than 180° and of an area with a radius no greater than 1,500 m.

If acoustic measurements indicate that ranges to isopleths corresponding to the Level A harassment and Level B harassment thresholds are less than the ranges predicted by modeling (assuming 10-dB attenuation), Revolution Wind may request a modification of the clearance and shutdown zones for impact pile driving of monopiles and for detonation of UXOs/MECs. For a modification request to be considered by NMFS, Revolution Wind would have had to conduct SFV on three or more monopiles and on all detonated UXOs/MECs thus far to verify that zone sizes are consistently smaller than those predicted by modeling (assuming 10-dB attenuation). In addition, if a subsequent monopile installation location is selected that was not represented by previous three locations (*i.e.*, substrate composition, water depth), SFV would be required. Furthermore, if a subsequent UXO/MEC charge weight is encountered and/or detonation location is selected that was not representative of the previous locations (*i.e.*, substrate composition, water depth), SFV would also be required. Upon receipt of an interim SFV report, NMFS may adjust zones (*i.e.*, Level A harassment, Level B harassment, clearance, shutdown, and/or minimum visibility zone) to reflect SFV measurements. The shutdown and clearance zones for pile driving would be equivalent to the measured range to the Level A harassment isopleths plus 10 percent (shutdown zone) and 20 percent (clearance zone), rounded up to the nearest 100 m for PSO clarity. The minimum visibility zone would be based on the largest measured distance to the Level A harassment isopleth for large whales. Regardless of SFV, a North Atlantic right whale detected at any distance by PSOs would continue to result in a delay to the start of pile driving. Similarly, if pile driving has commenced, shutdown would be called for in the event a right whale is observed at any distance. That is, the visual clearance and shutdown criteria for North

Atlantic right whales would not change, regardless of field acoustic measurements. The Level B harassment zone would be equal to the largest measured range to the Level B harassment isopleth.

The SFV plan must also include how operational noise would be monitored. Revolution Wind would be required to estimate source levels (at 10 m from the operating foundation) based on received levels measured at 50 m, 100 m, and 250 m from the pile foundation. These data must be used to identify estimated transmission loss rates. Operational parameters (*e.g.*, direct drive/gearbox information, turbine rotation rate) as well as sea state conditions and information on nearby anthropogenic activities (*e.g.*, vessels transiting or operating in the area) must be reported.

Revolution Wind must submit a SFV Plan at least 180 days prior to the planned start of impact pile driving and any UXO/MEC detonation activities. The plan must describe how Revolution Wind would ensure that the first three monopile foundation installation sites selected and each UXO/MEC detonation scenario (*i.e.*, charge weight, location) selected for SFV are representative of the rest of the monopile installation sites and UXO/MEC scenarios. Revolution Wind must include information on how additional sites/scenarios would be selected for SFV should it be determined that these sites/scenarios are not representative of all other monopile installation sites and UXO/MEC detonations. The plan must also include the methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. Revolution Wind must also provide, as soon as they are available but no later than 48 hours after each installation, the initial results of the SFV measurements to NMFS in an interim report after each monopile for the first three piles and after each UXO/MEC detonation.

Reporting

Prior to any construction activities occurring, Revolution Wind would provide a report to NMFS (at *itp.esch@noaa.gov* and *pr.itp.monitoringreports@noaa.gov*) documenting that all required training for Revolution Wind personnel (*i.e.*, vessel crews, vessel captains, PSOs, and PAM operators) has been completed.

NMFS would require standardized and frequent reporting from Revolution Wind during the life of the proposed regulations and LOA. All data collected relating to the Revolution Wind project would be recorded using industry-standard software (*e.g.*, Mysticetus or a similar software) installed on field laptops and/or tablets. Revolution Wind would be required to submit weekly, monthly and annual reports as described below. During activities requiring PSOs, the following information would be collected and reported related to the activity being conducted:

- Date and time that monitored activity begins or ends;
- Construction activities occurring during each observation period;
- Watch status (*i.e.*, sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- PSO who sighted the animal;
- Time of sighting;
- Weather parameters (*e.g.*, wind speed, percent cloud cover, visibility);
- Water conditions (*e.g.*, sea state, tide state, water depth);
- All marine mammal sightings, regardless of distance from the construction activity;
- Species (or lowest possible taxonomic level possible)
- Pace of the animal(s);

- Estimated number of animals (minimum/maximum/high/low/best);
- Estimated number of animals by cohort (*e.g.*, adults, yearlings, juveniles, calves, group composition, etc.);
- Description (*i.e.*, as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
- Description of any marine mammal behavioral observations (*e.g.*, observed behaviors such as feeding or traveling) and observed changes in behavior, including an assessment of behavioral responses thought to have resulted from the specific activity;
- Animal's closest distance and bearing from the pile being driven, UXO/MEC, or specified HRG equipment and estimated time entered or spent within the Level A harassment and/or Level B harassment zones;
- Construction activity at time of sighting (*e.g.*, vibratory installation/removal, impact pile driving, UXO/MEC detonation, HRG survey), use of any noise abatement device(s), and specific phase of activity (*e.g.*, ramp-up of HRG equipment, HRG acoustic source on/off, soft start for pile driving, active pile driving, post-UXO/MEC detonation, etc.);
- Description of any mitigation-related action implemented, or mitigation-related actions called for but not implemented, in response to the sighting (*e.g.*, delay, shutdown, etc.) and time and location of the action; and

- Other human activity in the area.

For all real-time acoustic detections of marine mammals, the following must be recorded and included in weekly, monthly, annual, and final reports:

a. Location of hydrophone (latitude & longitude; in Decimal Degrees) and site name;

b. Bottom depth and depth of recording unit (in meters);

c. Recorder (model & manufacturer) and platform type (*i.e.,* bottom-mounted, electric glider, etc.), and instrument ID of the hydrophone and recording platform (if applicable);

d. Time zone for sound files and recorded date/times in data and metadata (in relation to UTC. *i.e.*, EST time zone is UTC-5);

e. Duration of recordings (start/end dates and times; in ISO 8601 format, yyyy-mm-ddTHH:MM:SS.sssZ);

f. Deployment/retrieval dates and times (in ISO 8601 format);

g. Recording schedule (must be continuous);

h. Hydrophone and recorder sensitivity (in dB *re. 1 µPa*);

i. Calibration curve for each recorder;

j. Bandwidth/sampling rate (in Hz);

k. Sample bit-rate of recordings; and

l. Detection range of equipment for relevant frequency bands (in meters).

For each detection the following information must be noted:

a. Species identification (if possible);

b. Call type and number of calls (if known);

c. Temporal aspects of vocalization (date, time, duration, etc., date times in ISO 8601 format);

d. Confidence of detection (detected, or possibly detected);

e. Comparison with any concurrent visual sightings;

f. Location and/or directionality of call (if determined) relative to acoustic recorder or construction activities;

g. Location of recorder and construction activities at time of call;

h. Name and version of detection or sound analysis software used, with protocol reference;

i. Minimum and maximum frequencies viewed/monitored/used in detection (in Hz); and

j. Name of PAM operator(s) on duty.

If a North Atlantic right whale is detected via Revolution Wind PAM, the date, time, location (*i.e.*, latitude and longitude of recorder) of the detection as well as the recording platform that had the detection must be reported to *nmfs.pacmdata@noaa.gov* as soon as feasible, but no longer than 24 hours after the detection. Full detection data and metadata must be submitted monthly on the 15th of every month for the previous month via the webform on the NMFS North Atlantic right whale Passive Acoustic Reporting System website (*https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates*).

If a North Atlantic right whale is observed at any time by PSOs or personnel on or in the vicinity of any impact or vibratory pile-driving vessel, dedicated PSO vessel, construction survey vessel, during vessel transit, or during an aerial survey, Revolution Wind must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System (866) 755-6622, to the U.S. Coast Guard via channel 16, and through the WhaleAlert app (*https://www.whalealert.org/*) as soon as feasible but no longer than 24 hours after the sighting. Information reported must include, at a minimum: time of sighting, location, and number of North Atlantic right whales observed.

SFV Interim Report - Revolution Wind would be required to provide, as soon as they are available but no later than 48 hours after each installation, the initial results of SFV measurements to NMFS in an interim report after each monopile for the first three piles and any subsequent piles monitored. An SFV interim report must also be submitted within 48 hours after each UXO/MEC detonation.

Weekly Report - Revolution Wind would be required to compile and submit weekly PSO, PAM, and SFV reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that document the daily start and stop of all pile driving, pneumatic hammering, HRG survey, or UXO/MEC detonation activities, the start and stop of associated observation periods by PSOs, details on the deployment of PSOs, a record of all detections of marine mammals (acoustic and visual), any mitigation actions (or if mitigation actions could not be taken, provide reasons why), and details on the noise abatement system(s) used and its performance. Weekly reports would be due on Wednesday for the previous week (Sunday – Saturday). The weekly report would also identify which turbines become operational and when (a map must be provided). Once all foundation pile installation is complete, weekly reports would no longer be required.

Monthly Report - Revolution Wind would be required to compile and submit monthly reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that include a summary of all information in the weekly reports, including project activities carried out in the previous month, vessel transits (number, type of vessel, and route), number of piles installed, number of UXO/MEC detonations, all detections of marine mammals, and any mitigative actions taken. Monthly reports would be due on the 15th of the month for the previous month. The monthly report would also identify which turbines become operational and when (a map must be provided). Once foundation pile installation is complete, monthly reports would no longer be required.

Annual Report - Revolution Wind would be required to submit an annual PSO PAM, and SFV summary report to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) no later than 90 days following the end of a given calendar year describing, in detail, all of the information required in the monitoring section above. A final annual report would be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments were received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report would be considered final.

Final Report - Revolution Wind must submit its draft final report(s) to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) on all visual and acoustic monitoring conducted under the LOA within 90 calendar days of the completion of activities occurring under the LOA. A final report must be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 30 calendar days of NMFS' receipt of the draft report, the report shall be considered final.

Situational Reporting

Specific situations encountered during the development of the Revolution Wind project would require reporting. These situations and the relevant procedures include:

- If a marine mammal observation occurs during vessel transit, the following information must be recorded and reported:

  a. Time, date, and location;

  b. The vessel's activity, heading, and speed;

  c. Sea state, water depth, and visibility;

  d. Marine mammal identification to the best of the observer's ability (*e.g.*, North Atlantic right whale, whale, dolphin, seal);

  e. Initial distance and bearing to marine mammal from vessel and closest point of approach; and,

  f. Any avoidance measures taken in response to the marine mammal sighting.

- If a sighting of a stranded, entangled, injured, or dead marine mammal occurs, the sighting would be reported to NMFS OPR, the NMFS Greater Atlantic Regional Fisheries Office (GARFO) Marine Mammal and Sea Turtle Stranding & Entanglement Hotline (866-755-6622), and the U.S. Coast Guard within 24 hours. If the injury or death was caused by a project activity, Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:

g. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

h. Species identification (if known) or description of the animal(s) involved;

i. Condition of the animal(s) (including carcass condition if the animal is dead);

j. Observed behaviors of the animal(s), if alive;

k. If available, photographs or video footage of the animal(s); and

l. General circumstances under which the animal was discovered.

- In the event of a vessel strike of a marine mammal by any vessel associated with the Revolution Wind project, Revolution Wind shall immediately report the strike incident to the NMFS OPR and the GARFO within and no later than 24 hours. Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:

a. Time, date, and location (latitude/longitude) of the incident;

b. Species identification (if known) or description of the animal(s) involved;

c. Vessel's speed during and leading up to the incident;

d. Vessel's course/heading and what operations were being conducted (if applicable);

e. Status of all sound sources in use;

f. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

g. Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

h. Estimated size and length of animal that was struck;

i. Description of the behavior of the marine mammal immediately preceding and following the strike;

j. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

k. Estimated fate of the animal (*e.g.*, dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

l. To the extent practicable, photographs or video footage of the animal(s).

Sound Monitoring Reporting

As described previously, Revolution Wind would be required to provide the initial results of SFV (including measurements) to NMFS in interim reports after each monopile installation for the first three piles (and any subsequent piles) as soon as they are available, but no later than 48 hours after each installation. Revolution Wind would also have to provide interim reports after every UXO/MEC detonation as soon as they are available, but no later than 48 hours after each detonation. In addition to in situ measured ranges to the Level A harassment and Level B harassment isopleths, the acoustic monitoring report must include: hammer energies (pile driving), UXO/MEC weight (including donor charge weight), SPL_{peak}, SPL_{rms} that contains 90 percent of the acoustic energy, single strike sound exposure level, integration time for SPL_{rms}, and 24-hour cumulative SEL extrapolated from measurements. The sound levels reported must be in median and linear average (*i.e.*, average in linear space), and in dB. All these levels must be reported in the form of median, mean, max, and minimum. The SEL and SPL power spectral density and one-third octave band levels (usually calculated as decidecade band levels) at the receiver locations should be reported. The acoustic monitoring report must also include: a description of the SFV PAM hardware and software, including software version used, calibration data, bandwidth capability and sensitivity of hydrophone(s), any filters used in hardware or software, any limitations with the equipment, a description of the hydrophones used, hydrophone and water depth, distance to the pile driven, sediment type at the recording location, and local environmental conditions (*e.g.*, wind speed). In addition, pre- and post-activity ambient sound levels (broadband and/or within frequencies of concern) should be reported. Finally, the report must include a description of the noise abatement system and operational parameters (*e.g.*, bubble flow rate, distance deployed from the pile or UXO/MEC location, etc.), and any action taken to adjust the noise abatement system. Final results of SFV must be submitted as soon as possible, but no later than within 90 days following completion of impact pile driving of monopiles and UXOs/MECs detonations.

Adaptive Management

The regulations governing the take of marine mammals incidental to Revolution Wind's construction activities would contain an adaptive management component. The reporting requirements associated with this rule are designed to provide NMFS with monitoring data throughout the life of the project that can inform potential from completed projects to allow consideration of whether any changes to mitigation or monitoring are appropriate. The use of adaptive management allows NMFS to consider new information from different sources to determine (with input from Revolution Wind regarding practicability) on an annual or biennial basis if mitigation or monitoring measures should be modified (including additions or deletions). Mitigation measures could be modified if new data suggests that such modifications would have a reasonable likelihood of reducing adverse effects to marine mammals and if the measures are practicable.

The following are some of the possible sources of applicable data to be considered through the adaptive management process: (1) Results from monitoring reports, as required by MMPA authorizations; (2) results from general marine mammal and sound research; and (3) any information which reveals that marine mammals may have been taken in a manner, extent, or number not authorized by these regulations or subsequent LOA. During the course of the rule, Revolution Wind (and other LOA-holders conducting offshore wind development activities) would be required to participate in one or more adaptive management meetings convened by NMFS and/or BOEM, in which the above information would be summarized and discussed in the context of potential changes to the mitigation or monitoring measures.

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.*, population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be “taken” by mortality, serious injury, and Level A harassment or Level B harassment, we consider other factors, such as the likely nature of any behavioral responses (*e.g.*, intensity, duration), the context of any such responses (*e.g.*, critical reproductive time or location, migration), as well as effects on habitat, and the likely effectiveness of mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS’ implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.*, as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

In the **Estimated Take** section, we identified the subset of potential effects that would be expected to qualify as takes under the MMPA, and then identified the maximum number of takes by Level A harassment and Level B harassment that we estimate are reasonably expected to occur based on the methods described. The impact that any given take would have is dependent on many case-specific factors that need to be considered in the negligible impact analysis (*e.g.,* the context of behavioral exposures such as duration or intensity of a disturbance, the health of impacted animals, the status of a species that incurs fitness-level impacts to individuals, etc.). In this rule, we evaluate the likely impacts of the enumerated harassment takes that are proposed for authorization in the context of the specific circumstances surrounding these predicted takes. We also collectively evaluate this information, as well as other more taxa-specific information and mitigation measure effectiveness, in group-specific discussions that support our negligible impact conclusions for each stock. As also described above, no serious injury or mortality is expected or proposed for authorization for any species or stock.

The **Description of the Specified Activities** section describes the specified activities proposed by Revolution Wind that may result in take of marine mammals and an estimated schedule for conducting those activities. Revolution Wind has provided a realistic construction schedule (*e.g.*, Revolution Wind's schedule reflects the maximum number of piles they anticipate to be able to drive each month in which pile driving is authorized to occur), although we recognize schedules may shift for a variety of reasons (*e.g.*, weather or supply delays). However, the total amount of take would not exceed the 5 year totals and maximum annual total in any given year indicated in Tables 33 and 34, respectively.

We base our analysis and negligible impact determination (NID) on the maximum number of takes that would be reasonably expected to occur and are proposed to be authorized in the 5-year LOA, if issued, and extensive qualitative consideration of other contextual factors that influence the degree of impact of the takes on the affected individuals and the number and context of the individuals affected. As stated before, the number of takes, both annual and 5-year total, alone are only a part of the analysis. To avoid repetition, we provide some general analysis in this **Negligible Impact Analysis and Determination** section that applies to all the species listed in Table 4, given that some of the anticipated effects of Revolution Wind's construction activities on marine mammals are expected to be relatively similar in nature. Then, we subdivide into more detailed discussions for mysticetes, odontocetes, and pinnipeds which have broad life history traits that support an overarching discussion of some factors considered within the analysis for those groups (*e.g.,* habitat-use patterns*,* high-level differences in feeding strategies).

Last, we provide a negligible impact determination for each species or stock, providing species or stock-specific information or analysis, where appropriate, for example, for North Atlantic right whales given their population status. Organizing our analysis by grouping species or stocks that share common traits or that would respond similarly to effects of Revolution Wind's proposed activities, and then providing species- or stock-specific information allows us to avoid duplication while ensuring that we have analyzed the effects of the specified activities on each affected species or stock. It is important to note that in the group or species sections, we base our negligible impact analysis on the maximum annual take that is predicted under the 5-year rule; however, the majority of the impacts are associated with WTG and OSS foundation installation, which would occur largely within a 1-year period. The estimated take in the other years is expected to be notably less, which is reflected in the total take that would be allowable under the rule (see Tables 32, 33, and 34).

As described previously, no serious injury or mortality is anticipated or proposed for authorization in this rule. The amount of harassment Revolution Wind has requested, and NMFS is proposing to authorize, is based on exposure models that consider the outputs of acoustic source and propagation models. Several conservative parameters and assumptions are ingrained into these models, such as assuming forcing functions that consider direct contact with piles (*i.e.*, no cushion allowances) and application of the highest monthly sound speed profile to all months within a given season. In addition, the exposure model results do not reflect any mitigation measures (except for North Atlantic right whales) or avoidance response, and some of those results have been adjusted upward to consider sighting or group size data, where necessary. The resulting values for each stock were then used by Revolution Wind to request take by behavioral harassment. The only case in which mitigation measures (other than source level reduction via a noise abatement system) were considered is the potential for PTS (Level A harassment) of large whales. Models used to predict exposures for impact pile driving and UXO/MEC detonations predicted PTS exposures for multiple species. However, Revolution Wind did not request, and we are not proposing to authorize, Level A harassment of any baleen whale species other than humpback whales due, in large part, to the extended mitigation measures for large whales. Therefore, for all species, the amount of take proposed to be authorized represents the maximum amount of Level A harassment and Level B harassment that is reasonably expected to occur.

Behavioral Disturbance

In general, NMFS anticipates that impacts on an individual that has been harassed are likely to be more intense when exposed to higher received levels and for a longer duration (though this is in no way a strictly linear relationship for behavioral effects across species, individuals, or circumstances) and less severe impacts result when exposed to lower received levels and for a brief duration. However, there is also growing evidence of the importance of contextual factors such as distance from a source in predicting marine mammal behavioral response to sound—*i.e.*, sounds of a similar level emanating from a more distant source have been shown to be less likely to evoke a response of equal magnitude (*e.g.*, DeRuiter, 2012, Falcone *et al.,* 2017). As described in the **Potential Effects to Marine Mammals and their Habitat** section, the intensity and duration of any impact resulting from exposure to Revolution Wind's activities is dependent upon a number of contextual factors including, but not limited to, sound source frequencies, whether the sound source is moving towards the animal, hearing ranges of marine mammals, behavioral state at time of exposure, status of individual exposed (*e.g.*, reproductive status, age class, health) and an individual's experience with similar sound sources. Ellison *et al.* (2012) and Moore and Barlow (2013), among others, emphasize the importance of context (*e.g.,* behavioral state of the animals, distance from the sound source) in evaluating behavioral responses of marine mammals to acoustic sources. Harassment of marine mammals may result in behavioral modifications (*e.g.*, avoidance, temporary cessation of foraging or communicating, changes in respiration or group dynamics, masking) or may result in auditory impacts such as hearing loss. In addition, some of the lower level physiological stress responses (*e.g.,* orientation or startle response, change in respiration, change in heart rate) discussed previously would likely co-occur with the behavioral modifications, although these physiological responses are more difficult to detect and fewer data exist relating these responses to specific received levels of sound. Takes by Level B harassment, then, may have a stress-related physiological component as well; however, we would not expect Revolution Wind's activities to produce conditions of long-term and continuous exposure to noise leading to long-term physiological stress responses in marine mammals that could affect reproduction or survival.

In the range of potential behavioral effects that might be expected to be part of a response that qualifies as an instance of Level B harassment by behavioral disturbance (which by nature of the way it is modeled/counted, occurs within one day), the less severe end might include exposure to comparatively lower levels of a sound, at a greater distance from the animal, for a few or several minutes. A less severe exposure of this nature could result in a behavioral response such as avoiding an area that an animal would otherwise have chosen to move through or feed in for some amount of time, or breaking off one or a few feeding bouts. More severe effects could occur if an animal gets close enough to the source to receive a comparatively higher level, is exposed continuously to one source for a longer time, or is exposed intermittently to different sources throughout a day. Such effects might result in an animal having a more severe flight response, and leaving a larger area for a day or more or potentially losing feeding opportunities for a day. However, such severe behavioral effects are expected to occur infrequently.

Many species perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hour cycle). Behavioral reactions to noise exposure, when taking place in a biologically important context, such as disruption of critical life functions, displacement, or avoidance of important habitat, are more likely to be significant if they last more than one day or recur on subsequent days (Southall *et al.,* 2007) due to diel and lunar patterns in diving and foraging behaviors observed in many cetaceans (Baird *et al.,* 2008, Barlow *et al.,* 2020, Henderson *et al.,* 2016, Schorr *et al.,* 2014). It is important to note the water depth in the Revolution Wind project area is shallow (5 to 50 m) and deep diving species, such as sperm whales, are not expected to be engaging in deep foraging dives when exposed to noise above NMFS harassment thresholds during the specified activities. Therefore, we do not anticipate impacts to deep foraging behavior to be impacted by the specified activities.

It is also important to identify that the estimated number of takes does not necessarily equate to the number of individual animals Revolution Wind expects to harass (which is lower), but rather to the instances of take (*i.e.*, exposures above the Level B harassment thresholds) that are anticipated to occur. These instances may represent either brief exposures (*e.g.*, seconds for UXO/MEC detonation, or seconds to minutes for HRG surveys) or, in some cases, longer durations of exposure within a day (*e.g.*, pile driving). Some individuals of a species may experience recurring instances of take over multiple days throughout the year, while some members of a species or stock may experience one exposure as they move through an area or not experience take at all, which means that the number of individuals taken is smaller than the total estimated takes. In short, for species that are more likely to be migrating through the area and/or for which only a comparatively smaller number of takes are predicted (*e.g.*, some of the mysticetes), it is more likely that each take represents a different individual, whereas for non-migrating species with larger amounts of predicted take, we expect that the total anticipated takes represent exposures of a smaller number of individuals of which some would be exposed multiple times.

For the Revolution Wind project, impact pile driving is most likely to result in a higher magnitude and severity of behavioral disturbance than other activities (*i.e.*, vibratory pile driving, UXO/MEC detonation, and HRG surveys). Impact pile driving has higher source levels than vibratory pile driving and HRG sources. HRG survey equipment also produces much higher frequencies than pile driving, resulting in minimal sound propagation. While UXO/MEC detonations may have higher source levels, impact pile driving is planned for longer durations (*i.e.*, a maximum of 13 UXO/MEC detonations are planned, which would result in only instantaneous exposures). While impact pile driving is anticipated to be most impactful for these reasons, impacts are minimized through implementation of mitigation measures, including soft-start, use of a sound attenuation system, and the implementation of clearance zones that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in Level B harassment. Given sufficient notice through the use of soft-start, marine mammals are expected to move away from a sound source that is annoying prior to becoming exposed to very loud noise levels. The requirement that pile driving can only commence when the full extent of all clearance zones are fully visible to visual PSOs would ensure a higher marine mammal detection, enabling a high rate of success in implementation of clearance zones. Furthermore, Revolution Wind would be required to utilize PAM prior to and during all clearance periods, during impact pile driving, and after pile driving has ended during the post-piling period. PAM has been shown to be particularly effective when used in conjunction with visual observations, increasing the overall capability to detect marine mammals (Van Parijs *et al.*, 2021). These measures also apply to UXO/MEC detonation(s), which also have the potential to elicit more severe behavioral reactions in the unlikely event that an animal is relatively close to the explosion in the instant that it occurs; hence, severity of behavioral responses are expected to be lower than would be the case without mitigation.

Occasional, milder behavioral reactions are unlikely to cause long-term consequences for individual animals or populations, and even if some smaller subset of the takes are in the form of a longer (several hours or a day) and more severe response, if they are not expected to be repeated over sequential days, impacts to individual fitness are not anticipated. Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer *et al.*, 2018; Harris *et al.*, 2017; King *et al.*, 2015; NAS 2017; New *et al.,* 2014; Southall *et al.*, 2007; Villegas-Amtmann *et al.*, 2015).

Temporary Threshold Shift (TTS)

TTS is one form of Level B harassment that marine mammals may incur through exposure to Revolution Wind's activities and, as described earlier, the proposed takes by Level B harassment may represent takes in the form of behavioral disturbance, TTS, or both. As discussed in the **Potential Effects to Marine Mammals and their Habitat** section, in general, TTS can last from a few minutes to days, be of varying degree, and occur across different frequency bandwidths, all of which determine the severity of the impacts on the affected individual, which can range from minor to more severe. Impact and vibratory pile driving generate sounds in the lower frequency ranges (with most of the energy below 1-2 kHz, but with a small amount energy ranging up to 20 kHz); therefore, in general and all else being equal, we would anticipate the potential for TTS is higher in low-frequency cetaceans (*i.e.*, mysticetes) than other marine mammal hearing groups and would be more likely to occur in frequency bands in which they communicate. However, we would not expect the TTS to span the entire communication or hearing range of any species given the frequencies produced by pile driving do not span entire hearing ranges for any particular species. Additionally, though the frequency range of TTS that marine mammals might sustain would overlap with some of the frequency ranges of their vocalizations, the frequency range of TTS from Revolution Wind's pile driving and UXO/MEC detonation activities would not typically span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. However, the mitigation measures proposed by Revolution Wind and proposed by NMFS, further reduce the potential for TTS in mysticetes.

Generally, both the degree of TTS and the duration of TTS would be greater if the marine mammal is exposed to a higher level of energy (which would occur when the peak dB level is higher or the duration is longer). The threshold for the onset of TTS was discussed previously (refer back to Table 10). However, source level alone is not a predictor of TTS. An animal would have to approach closer to the source or remain in the vicinity of the sound source appreciably longer to increase the received SEL, which would be difficult considering the proposed mitigation and the nominal speed of the receiving animal relative to the stationary sources such as impact pile driving. The recovery time of TTS is also of importance when considering the potential impacts from TTS. In TTS laboratory studies (as discussed in the **Potential Effects to Marine Mammals and their Habitat** section), some using exposures of almost an hour in duration or up to 217 SEL, almost all individuals recovered within 1 day (or less, often in minutes) and we note that while the pile driving activities last for hours a day, it is unlikely that most marine mammals would stay in the close vicinity of the source long enough to incur more severe TTS. UXO/MEC detonation also has the potential to result in TTS; however, given the duration of exposure is extremely short (milliseconds), the degree of TTS (*i.e.*, the amount of dB shift) is expected to be small and TTS duration is expected to be short (minutes to hours). Overall, given the small number of times that any individual might incur TTS, the low degree of TTS and the short anticipated duration, and the unlikely scenario that any TTS overlapped the entirety of a critical hearing range, it is unlikely that TTS of the nature expected to result from Revolution Wind's activities would result in behavioral changes or other impacts that would impact any individual's (of any hearing sensitivity) reproduction or survival.

Permanent Threshold Shift (PTS)

Revolution Wind has requested, and NMFS proposed to authorize, a very small amount of take by PTS to some marine mammal individuals. The numbers of proposed annual takes by Level A harassment are relatively low for all marine mammal stocks and species: humpback whales (7 takes), harbor porpoises (49 takes), gray seals (7 takes), and harbor seals (16 takes). The only activities incidental to which we anticipate PTS may occur is from exposure to impact pile driving and UXO/MEC detonations, which produce sounds that are both impulsive and primarily concentrated in the lower frequency ranges (below 1 kHz) (David, 2006; Krumpel *et al.*, 2021).

There are no PTS data on cetaceans and only one instance of PTS being induced in an older harbor seals (Reichmuth *et al.*, 2019); however, available TTS data (of mid-frequency hearing specialists exposed to mid- or high-frequency sounds (Southall *et al.,* 2007; NMFS 2018; Southall *et al.*, 2019)) suggest that most threshold shifts occur in the frequency range of the source up to one octave higher than the source. We would anticipate a similar result for PTS. Further, no more than a small degree of PTS is expected to be associated with any of the incurred Level A harassment, given it is unlikely that animals would stay in the close vicinity of a source for a duration long enough to produce more than a small degree of PTS.

PTS would consist of minor degradation of hearing capabilities occurring predominantly at frequencies one-half to one octave above the frequency of the energy produced by pile driving or instantaneous UXO/MEC detonation (*i.e.*, the low-frequency region below 2 kHz) (Cody and Johnstone, 1981; McFadden, 1986; Finneran, 2015), not severe hearing impairment. If hearing impairment occurs from either impact pile driving or UXO/MEC detonation, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics. However, given sufficient notice through use of soft-start prior to implementation of full hammer energy during impact pile driving, marine mammals are expected to move away from a sound source that is annoying prior to it resulting in severe PTS. Revolution estimates up to 13 UXOs/MECs may be detonated and the exposure analysis assumes the worst-case scenario that all of the UXOs/MECs found would consist of the largest charge weight of UXO/MEC (E12; 454 kg). However, it is highly unlikely that all charges would be this maximum size, thus the amount of take incidental to the detonation of the 13 UXOs/MECs would likely be less than what is estimated here. Furthermore, Revolution Wind plans to implement sound attenuation during UXO/MEC detonations, to the extent practicable, that would further be expected to reduce take of marine mammals. Nonetheless, this negligible impact analysis considers the effects of the takes that are conservatively proposed for authorization.

Auditory Masking or Communication Impairment

The ultimate potential impacts of masking on an individual are similar to those discussed for TTS (*e.g.*, decreased ability to communicate, forage effectively, or detect predators), but an important difference is that masking only occurs during the time of the signal, versus TTS, which continues beyond the duration of the signal. Also, though, masking can result from the sum of exposure to multiple signals, none of which might individually cause TTS. Fundamentally, masking is referred to as a chronic effect because one of the key potential harmful components of masking is its duration—the fact that an animal would have reduced ability to hear or interpret critical cues becomes much more likely to cause a problem the longer it is occurring. Also inherent in the concept of masking is the fact that the potential for the effect is only present during the times that the animal and the source are in close enough proximity for the effect to occur (and further, this time period would need to coincide with a time that the animal was utilizing sounds at the masked frequency). As our analysis has indicated, for this project we expect that impact pile driving foundations have the greatest potential to mask marine mammal signals, and this pile driving may occur for several, albeit intermittent, hours per day. Masking is fundamentally more of a concern at lower frequencies (which are pile driving dominant frequencies), because low frequency signals propagate significantly further than higher frequencies and because they are more likely to overlap both the narrower low frequency calls of mysticetes, as well as many non-communication cues related to fish and invertebrate prey, and geologic sounds that inform navigation. However, the area in which masking would occur for all marine mammal species and stocks (*e.g.*, predominantly in the vicinity of the foundation pile being driven) is small relative to the extent of habitat used by each species and stock. In summary, the nature of Revolution Wind's activities, paired with habitat use patterns by marine mammals, does not support the likelihood that the level of masking that could occur would have the potential to affect reproductive success or survival.

Impacts on Habitat and Prey

Construction activities or UXO/MEC detonation may result in fish and invertebrate mortality or injury very close to the source, and all activities (including HRG surveys) may cause some fish to leave the area of disturbance. It is anticipated that any mortality or injury would be limited to a very small subset of available prey and the implementation of mitigation measures such as the use of a noise attenuation system during impact pile driving and UXO/MEC detonation would further limit the degree of impact (again noting UXO/MEC detonation would be limited to 13 events over 5 years).

Behavioral changes in prey in response to construction activities could temporarily impact marine mammals' foraging opportunities in a limited portion of the foraging range but, because of the relatively small area of the habitat that may be affected at any given time (*e.g.*, around a pile being driven), the impacts to marine mammal habitat are not expected to cause significant or long-term negative consequences.

Cable presence and operation are not anticipated to impact marine mammal habitat as these would be buried, and any electromagnetic fields emanating from the cables are not anticipated to result in consequences that would impact marine mammals prey to the extent they would be unavailable for consumption.

The presence and operation of wind turbines within the lease area could have longer-term impacts on marine mammal habitat, as the project would result in the persistence of the structures within marine mammal habitat for more than 30 years. The presence and operation of an extensive number of structures such as wind turbines are, in general, likely to result in local and broader oceanographic effects in the marine environment, and may disrupt dense aggregations and distribution of marine mammal zooplankton prey through altering the strength of tidal currents and associated fronts, changes in stratification, primary production, the degree of mixing, and stratification in the water column (Chen *et al*., 2021, Johnson *et al.,* 2021, Christiansen *et al.,* 2022, Dorrell *et al.,* 2022). However, the scale of impacts is difficult to predict and may vary from hundreds of meters for local individual turbine impacts (Schultze *et al*., 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers (Christiansen *et al*., 2022). In 2022, NMFS hosted a workshop to better understand the current scientific knowledge and data gaps around the potential long-term impacts of offshore wind farm operations in the Atlantic Ocean. The report from that workshop is pending and NMFS will consider its findings in development of the final rule for this action.

As discussed in the **Potential Effects to Marine Mammals and Their Habitat** section, the RWF would consist of no more than 79 turbines (scheduled to be operational by Year 2 of the effective period of the rule) in New England coastal waters, an area dominated by physical oceanographic patterns of strong seasonal stratification (summer) and turbulence-driven mixing (winter). While there are likely to be local oceanographic impacts from the presence and operation of the RWF, meaningful oceanographic impacts relative to stratification and mixing that would significantly affect marine mammal habitat and prey over large areas in key foraging habitats are not anticipated from the Revolution Wind project. Although this area supports aggregations of zooplankton (baleen whale prey) that could be impacted if long-term oceanographic changes occurred, prey densities are typically significantly less in the Revolution Wind project area than in known baleen whale foraging habitats to the east and north (*e.g.*, south of Nantucket and Martha's Vineyard, Great South Channel). For these reasons, if oceanographic features are affected by wind farm operation during the course of the proposed rule (approximately Years 2-5), the impact on marine mammal habitat and their prey is likely to be comparatively minor.

Mitigation to Reduce Impacts on All Species

This proposed rulemaking includes a variety of mitigation measures designed to minimize impacts on all marine mammals, with a focus on North Atlantic right whales (the latter is described in more detail below). For impact pile driving of foundation piles, eight overarching mitigation measures are proposed, which are intended to reduce both the number and intensity of marine mammal takes: (1) seasonal/time of day work restrictions; (2) use of multiple PSOs to visually observe for marine mammals (with any detection within designated zones triggering delay or shutdown); (3) use of PAM to acoustically detect marine mammals, with a focus on detecting baleen whales (with any detection within designated zones triggering delay or shutdown); (4) implementation of clearance zones; (5) implementation of shutdown zones; (6) use of soft-start; (7) use of noise abatement technology; and, (8) maintaining situational awareness of marine mammal presence through the requirement that any marine mammal sighting(s) by Revolution Wind project personnel must be reported to PSOs.

When monopile foundation installation does occur, Revolution Wind is committed to reducing the noise levels generated by impact pile driving to the lowest levels practicable and ensuring that they do not exceed a noise footprint above that which was modeled, assuming a 10-dB attenuation. Use of a soft-start would allow animals to move away from (*i.e.*, avoid) the sound source prior to the elevation of the hammer energy to the level maximally needed to install the pile (Revolution Wind would not use a hammer energy greater than necessary to install piles). Clearance zone and shutdown zone implementation, required when marine mammals are within given distances associated with certain impact thresholds, would reduce the magnitude and severity of marine mammal take.

Revolution Wind has indicated that up to three piles per day (*i.e.*, 12 hours of impact pile driving over 24 hours) could occur under ideal conditions; however, it is more likely that, given the complexities of installation, the average rate would be two piles per day (*i.e.*, 8 hours of activity pile driving per day). Revolution Wind has indicated that a monopile installation sequence would occur over up to nine hours; however, this entire period would not consist of active hammering, as a considerable portion of this time would be needed to move vessels and equipment to set up additional monopiles. Specifically, the application notes that "installation of a single pile at a minimum would involve a 1-hour pre-clearance period, up to 4 hours of piling, and 4 hours to move to the next piling location where the process would begin again." The full 9-hour installation sequence period would also consist of other activities outside of active impact driving that are not likely to harass marine mammals (*e.g.*, vessel transit, equipment set-up, pre-clearance monitoring by visual PSOs and PAM operators).

Revolution proposed, and NMFS would require, use a noise attenuation device (likely a big bubble curtain and another technology, such as a hydro-sound damper) during all foundation pile driving to ensure sound generated from the project does not exceed that modeled (assuming 10-dB reduction) distances to harassment isopleths and to minimize noise levels to the lowest level practicable. Double big bubble curtains are successfully and widely applied across European wind development efforts, and are known to reduce noise levels more than a single big bubble curtain alone (*e.g.*, see Bellman *et al*., 2020).

Mysticetes

Six mysticete species (comprising six stocks) of cetaceans (North Atlantic right whale, humpback whale, fin whale, blue whale, sei whale, and minke whale) are proposed to be taken by harassment. These species, to varying extents, utilize coastal New England waters, including the project area, for the purposes of migration and foraging.

Behavioral data on mysticete reactions to pile driving noise is scant. Kraus *et al.* (2019) predicted that the three main impacts of offshore wind farms on marine mammals would consist of displacement, behavioral disruptions, and stress. Broadly, we can look to studies that have focused on other noise sources such as seismic surveys and military training exercises, which suggest that exposure to loud signals can result in avoidance of the sound source (or displacement if the activity continues for a longer duration in a place where individuals would otherwise have been staying, which is less likely for mysticetes in this area), disruption of foraging activities (if they are occurring in the area), local masking around the source, associated stress responses, and impacts to prey, as well as TTS or PTS in some cases.

Mysticetes encountered in the Revolution Wind project area are expected to be migrating through and/or foraging within the project area; the extent to which an animal engages in these behaviors in the area is species-specific and varies seasonally. Given that extensive feeding BIAs for the North Atlantic right whale, humpback whale, fin whale, sei whale, and minke whale exist to the east and north of the project area (LaBrecque *et al*., 2015; Van Parijs *et al*., 2015), many mysticetes are expected to predominantly be migrating through the project area towards or from these feeding habitats. However, the extent to which particular species are utilizing the project area and nearby habitats (*i.e.*, south of Martha's Vineyard and Nantucket) for foraging or other activities is changing, particularly right whales (*e.g.*, O'Brien *et al*., 2021; Quintana-Rizzo *et al*., 2021), thus our understanding of the temporal and spatial occurrence of right whales and other mysticete species is continuing to be informed by ongoing monitoring efforts. While we have acknowledged above that mortality, hearing impairment, or displacement of mysticete prey species may result locally from impact pile driving or UXO/MEC detonation, given the very short duration of UXO/MEC detonation and limited amount over 5 years, and broad availability of prey species in the area and the availability of alternative suitable foraging habitat for the mysticete species most likely to be affected, any impacts on mysticete foraging would be expected to be minor. Whales temporarily displaced from the proposed project area would be expected to have sufficient remaining feeding habitat available to them, and would not be prevented from feeding in other areas within the biologically important feeding habitats. In addition, any displacement of whales or interruption of foraging bouts would be expected to be temporary in nature.

The potential for repeated exposures is dependent upon the residency time of whales, with migratory animals unlikely to be exposed on repeated occasions and animals remaining in the area to be more likely exposed repeatedly. Where relatively low amounts of species-specific proposed Level B harassment are predicted (compared to the abundance of each mysticete species or stock, such as is indicated in Table 34 here) and movement patterns suggest that individuals would not necessarily linger in a particular area for multiple days, each predicted take likely represents an exposure of a different individual; the behavioral impacts would, therefore, be expected to occur within a single day within a year–an amount that would not be expected to impact reproduction or survival. Alternatively, species with longer residence time in the project area may be subject to repeated exposures. In general, for this project, the duration of exposures would not be continuous throughout any given day and pile driving would not occur on all consecutive days within a given year, due to weather delays or any number of logistical constraints Revolution Wind has identified. Species-specific analysis regarding potential for repeated exposures and impacts is provided below. Overall, we do not expect impacts to whales within project area habitat, including fin whales foraging in the fin whale feeding BIA, to affect the fitness of any large whales.

The humpback whale is the only mysticete species for which PTS is anticipated and proposed to be authorized. As described previously, PTS for mysticetes from impact pile driving may overlap frequencies used for communication, navigation, or detecting prey. However, given the nature and duration of the activity, the mitigation measures, and likely avoidance behavior, any PTS is expected to be of a small degree, would be limited to frequencies where pile driving noise is concentrated (*i.e.*, only a small subset of their expected hearing range) and would not be expected to impact reproductive success or survival.

North Atlantic Right Whales

North Atlantic right whales are listed as endangered under the ESA and, as described in the **Effects to Marine Mammals and Their Habitat** section, are threatened by a low population abundance, higher than average mortality rates, and lower than average reproductive rates. Recent studies have reported individuals showing high stress levels (*e.g.,* Corkeron *et al.*, 2017) and poor health, which has further implications on reproductive success and calf survival (Christiansen *et al.*, 2020; Stewart *et al.*, 2021; Stewart *et al*., 2022). Given this, the status of the North Atlantic right whale population is of heightened concern and, therefore, merits additional analysis and consideration. NMFS proposes to authorize a maximum of 44 takes of North Atlantic right whales, by Level B harassment only, in any given year (likely Year 1), with no more than 56 takes incidental to all construction activities over the 5-year period of effectiveness of this proposed rule.

As described above, the project area represents part of an important migratory and potential feeding area for right whales. Quintana-Rizzo *et al*. (2021) noted different degrees of residency (*i.e.*, the minimum number of days an individual remained in southern New England) for right whales, with individual sighting frequency ranging from 1 to 10 days. The study results indicate that southern New England may, in part, be a stopover site for migrating right whales moving to or from southeastern calving grounds. The right whales observed during the study period were primarily concentrated in the northeastern and southeastern sections of the MA WEA during the summer (June-August) and winter (December-February), rather than in OCS-A 0486, which is to the west in the RI/MA WEA (see Figure 5 in Quintano-Rizzo *et al*., 2021). Right whale distribution did shift to the west into the RI/MA WEA in the spring (March-May), although sightings within the Revolution Wind project area were few compared to other portions of the WEA during this time. Overall, the Revolution Wind project area contains habitat less frequently utilized by North Atlantic right whales than the more easterly Southern New England region.

In general, North Atlantic right whales in southern New England are expected to be engaging in migratory or foraging behavior (Quintano-Rizzo *et al*., 2021). Model outputs suggest that 23 percent of the species' population is present in this region from

December through May, and the mean residence time has tripled to an average of 13 days during these months. Given the species' migratory behavior in the project area, we anticipate individual whales would be typically migrating through the area during most months when foundation installation and UXO/MEC detonation would occur (given the seasonal restrictions on foundation installation from January through April and UXO/MEC detonation from December through April), rather than lingering for extended periods of time. Other work that involves either much smaller harassment zones (*e.g.*, HRG surveys) or is limited in amount (cable landfall construction) may occur during periods when North Atlantic right whales are using the habitat for both migration and foraging. Therefore, it is likely that many of the exposures would occur to individual whales; however, some may be repeat takes of the same animal across multiple days for some short period of time given residency data (*e.g.*, 13 days during December through May). It is important to note the activities occurring from December through May that may impact North Atlantic right whale would be primarily HRG surveys and cable landfall construction, neither of which would result in very high received levels. Across all years, while it is possible an animal could have been exposed during a previous year, the low amount of take proposed to be authorized during the 5-year period of the proposed rule makes this scenario possible but unlikely. However, if an individual were to be exposed during a subsequent year, the impact of that exposure is likely independent of the previous exposure given the duration between exposures.

North Atlantic right whales are presently experiencing an ongoing UME (beginning in June 2017). Preliminary findings support human interactions, specifically vessel strikes and entanglements, as the cause of death for the majority of North Atlantic right whales. Given the current status of the North Atlantic right whale, the loss of even one individual could significantly impact the population. No mortality, serious injury, or injury of North Atlantic right whales as a result of the project is expected or proposed to be authorized. Any disturbance to North Atlantic right whales due to Revolution Wind's activities is expected to result in temporary avoidance of the immediate area of construction. As no injury, serious injury, or mortality is expected or authorized, and Level B harassment of North Atlantic right whales will be reduced to the level of least practicable adverse impact through use of mitigation measures, the authorized number of takes of North Atlantic right whales would not exacerbate or compound the effects of the ongoing UME in any way.

As described in the general Mysticete section above, impact pile driving (assuming WTG and OSS monopile build-out) has the potential to result in the highest amount of annual take (44 Level B harassment takes) and is of greatest concern given loud source levels. This activity would likely be limited to 1 year, during times when North Atlantic right whales are not present in high numbers and are likely to be primarily migrating to more northern foraging grounds, with the potential for some foraging occurring in or near the project area. The potential types, severity, and magnitude of impacts are also anticipated to mirror that described in the general mysticete section above, including avoidance (the most likely outcome), changes in foraging or vocalization behavior, masking, a small amount of TTS, and temporary physiological impacts (*e.g.*, change in respiration, change in heart rate). Importantly, the effects of the activities proposed by Revolution Wind are expected to be sufficiently low-level and localized to specific areas as to not meaningfully impact important behaviors such as migratory or foraging behavior of North Atlantic right whales. As described above, 56 total instances of take are proposed for authorization, each occurring within a day, with the majority of takes (44) occurring within 1 year and the remaining 12 occurring over the remaining four years of the effective period of the rule. If this number of exposures results in temporary behavioral reactions, such as slight displacement (but not abandonment) of migratory habitat or temporary cessation of feeding, it is unlikely to result in energetic consequences that could affect reproduction or survival of any individuals. As described above, North Atlantic right whales are primarily foraging during December through May when the vast majority of take from impact pile driving would not occur (given the seasonal restriction from January 1-April 31). Overall, NMFS expects that any harassment of North Atlantic right whales incidental to the specified activities would not result in changes to their migration patterns or foraging behavior, as only temporary avoidance of an area during construction is expected to occur. As described previously, right whales migrating through and/or foraging in these areas are not expected to remain in this habitat for extensive durations, relative to nearby habitats such as south of Nantucket and Martha's Vineyard or the Great South Channel (known core foraging habitats) (Quintana-Rizzo *et al.*, 2021), and that any temporarily displaced animals would be able to return to or continue to travel through and forage in these areas once activities have ceased.

Although acoustic masking may occur, based on the acoustic characteristics of noise associated with pile driving (*e.g.*, frequency spectra, short duration of exposure) and construction surveys (*e.g.*, intermittent signals), NMFS expects masking effects to be minimal (*e.g.*, impact or vibratory pile driving) to none (*e.g.*, construction surveys). In addition, masking would likely only occur during the period of time that a North Atlantic right whale is in the relatively close vicinity of pile driving, which is expected to be infrequent and brief, given time of year restrictions, anticipated mitigation effectiveness, and likely avoidance behaviors. TTS is another potential form of Level B harassment that could result in brief periods of slightly reduced hearing sensitivity, affecting behavioral patterns by making it more difficult to hear or interpret acoustic cues within the frequency range (and slightly above) of sound produced during impact pile driving; however, any TTS would likely be of low amount, be limited to frequencies where most construction noise is centered (below 2 kHz). NMFS expects that right whale hearing sensitivity would return to pre-exposure levels shortly after migrating through the area or moving away from the sound source.

As described in the **Potential Effects to Marine Mammals and Their Habitat** section, the distance of the receiver to the source influences the severity of response with greater distances typically eliciting less severe responses. Additionally, NMFS recognizes North Atlantic right whales migrating could be pregnant females (in the fall) and cows with older calves (in spring) and that these animals may slightly alter their migration course in response to any foundation pile driving; however, as described in the **Potential Effects to Marine Mammals and Their Habitat** section, we anticipate that course diversion would be of small magnitude. Hence, while some avoidance of the pile driving activities may occur, we anticipate any avoidance behavior of migratory right whales would be similar to that of gray whales (Tyack and Clark, 1983), on the order of hundreds of meters up to 1 to 2 km. This diversion from a migratory path otherwise uninterrupted by Revolution Wind activities, or from lower quality foraging habitat (relative to nearby areas), is not expected to result in meaningful energetic costs that would impact annual rates of recruitment of survival. NMFS expects that North Atlantic right whales would be able to avoid areas during periods of active noise production, while not being forced out of this portion of their habitat.

North Atlantic right whale presence in the Revolution Wind project area is year-round; however, abundance during summer months is lower compared to the winter months, with spring and fall serving as "shoulder seasons," wherein abundance waxes (fall) or wanes (spring). Given this year-round habitat usage, in recognition that where and when whales may actually occur during project activities is unknown as it depends on the annual migratory behaviors, the applicant has proposed and NMFS is proposing to require a suite of mitigation measures designed to reduce impacts to North Atlantic right whales to the maximum extent practicable. These mitigation measures (*e.g.*, seasonal/daily work restrictions, vessel separation distances, reduced vessel speed) would not only avoid the likelihood of ship strikes, but also would minimize the severity of behavioral disruptions by minimizing impacts (*e.g.*, through sound reduction using abatement systems and reduced temporal overlap of project activities and North Atlantic right whales). This would further ensure that the number of takes, by Level B harassment, that are estimated to occur are not expected to affect reproductive success or survivorship via detrimental impacts to energy intake or cow/calf interactions during migratory transit. However, even in consideration of recent habitat-use and distribution shifts, Revolution Wind would still be installing monopiles when the presence of North Atlantic right whales is expected to be lower.

As described in the **Description of Marine Mammals in the Area of Specified Activities** section, Revolution Wind would be constructed within the North Atlantic right whale migratory corridor BIA which represent areas and months within which a substantial portion of a species or population is known to migrate. Off the south coast of Massachusetts and Rhode Island, this BIA extends from the coast to beyond the shelf break. The Revolution Wind project area is relatively small compared with the migratory BIA area (approximately 339 km^2 versus the size of the full North Atlantic right whale migratory BIA, 269,448 km^2). Because of this, overall North Atlantic right whale migration is not expected to be impacted by the proposed activities. There are no known North Atlantic right whale mating or calving areas within the project area. Impact pile driving, which is responsible for the majority of North Atlantic right whale impacts, would be limited to a maximum of 12 hours per day (three intermittent 4-hour events); therefore, if foraging activity is disrupted due to pile driving, any disruption would be brief as North Atlantic right whales would likely resume foraging after pile driving ceases or when animals move to another nearby location to forage. Prey species are mobile (*e.g.*, calanoid copepods can initiate rapid and directed escape responses) and are broadly distributed throughout the project area (noting again that North Atlantic right whale prey is not particularly concentrated in the project area relative to nearby habitats); therefore, any impacts to prey that may occur are also unlikely to impact marine mammals.

The most significant measure to minimize impacts to individual North Atlantic right whales during monopile installations is the seasonal moratorium on impact pile driving of monopiles from January 1 through April 30, when North Atlantic right whale abundance in the project area is expected to be highest. NMFS also expects this measure to greatly reduce the potential for mother-calf pairs to be exposed to impact pile driving noise above the Level B harassment threshold during their annual spring migration through the project area from calving grounds to primary foraging grounds (*e.g.*, Cape Cod Bay). Further, NMFS expects that exposures to North Atlantic right whales would be reduced due to the additional proposed mitigation measures that would ensure that any exposures above the Level B harassment threshold would result in only short-term effects to individuals exposed. Impact pile driving may only begin in the absence of North Atlantic right whales (based on visual and passive acoustic monitoring). If impact pile driving has commenced, NMFS anticipates North Atlantic right whales would avoid the area, utilizing nearby waters to carry on pre-exposure behaviors. However, impact pile driving must be shut down if a North Atlantic right whale is sighted at any distance, unless a shutdown is not feasible due to risk of injury or loss of life. Shutdown may occur anywhere if right whales are seen within or beyond the Level B harassment zone, further minimizing the duration and intensity of exposure. NMFS anticipates that if North Atlantic right whales go undetected and they are exposed to impact pile driving noise, it is unlikely a North Atlantic right whale would approach the impact pile driving locations to the degree that they would purposely expose themselves to very high noise levels. These measures are designed to avoid PTS and also reduce the severity of Level B harassment, including the potential for TTS. While some TTS could occur, given the proposed mitigation measures (*e.g.*, delay pile driving upon a sighting or acoustic detection and shutting down upon a sighting or acoustic detection), the potential for TTS to occur is low.

The proposed clearance and shutdown measures are most effective when detection efficiency is maximized, as the measures are triggered by a sighting or acoustic detection. To maximize detection efficiency, Revolution Wind proposed, and NMFS is proposed to require, the combination of PAM and visual observers (as well as communication protocols with other Revolution Wind vessels, and other heightened awareness efforts such as daily monitoring of North Atlantic right whale sighting databases) such that as a North Atlantic right whale approaches the source (and thereby could be exposed to higher noise energy levels), PSO detection efficacy would increase, the whale would be detected, and a delay to commencing pile driving or shutdown (if feasible) would occur. In addition, the implementation of a soft start would provide an opportunity for whales to move away from the source if they are undetected, reducing received levels. Further, Revolution Wind has committed to not installing two WTG or OSS foundations simultaneously. North Atlantic right whales would, therefore, not be exposed to concurrent impact pile driving on any given day and the area ensonified at any given time would be limited. We note that Revolution Wind has requested to install foundation piles at night which does raise concern over detection capabilities. Revolution Wind is currently conducting detection capability studies using alternative technology and intends to submit the results of these studies to NMFS. In consultation with BOEM, NMFS will review the results and determine if Revolution Wind should be allowed to conduct pile driving at night.

Although the temporary cofferdam Level B harassment zone is large (9,740 km to the unweighted Level B harassment threshold; Table 27 in the ITA application), the cofferdams would be installed within Narragansett Bay over a short timeframe (56 hours total; 28 hours for installation and 28 hours for removal). Therefore, it is also unlikely that any North Atlantic right whales would be exposed to concurrent vibratory and impact pile installation noises. Any UXO/MEC detonations, if determined to be necessary, would only occur in daylight and if all other low-order methods or removal of the explosive equipment of the device are determined to not be possible. Given that specific locations for the 13 possible UXOs/MECs are not presently known, Revolution Wind has agreed to undertake specific mitigation measures to reduce impacts on any North Atlantic right whales, including the use of a sound attenuation device (*i.e.*, likely a bubble curtain and another device) to achieve a minimum of 10-dB attenuation, and not detonating a UXO/MEC if a North Atlantic right whale is observed within the large whale clearance zone (10 km). Finally, for HRG surveys, the maximum distance to the Level B harassment isopleth is 141 m. The estimated take, by Level B harassment only, associated with HRG surveys is to account for any North Atlantic right whale sightings PSOs may miss when HRG acoustic sources are active. However, because of the short maximum distance to the Level B harassment isopleth (141 m), the requirement that vessels maintain a distance of 500 m from any North Atlantic right whales, the fact whales are unlikely to remain in close proximity to an HRG survey vessel for any length of time, and that the acoustic source would be shutdown if a North Atlantic right whale is observed within 500 m of the source, any exposure to noise levels above the harassment threshold (if any) would be very brief. To further minimize exposures, ramp-up of boomers, sparkers, and CHIRPs must be delayed during the clearance period if PSOs detect a North Atlantic right whale (or any other ESA-listed species) within 500 m of the acoustic source. With implementation of the proposed mitigation requirements, take by Level A harassment is unlikely and, therefore, not proposed for authorization. Potential impacts associated with Level B harassment would include low-level, temporary behavioral modifications, most likely in the form of avoidance behavior. Given the high level of precautions taken to minimize both the amount and intensity of Level B harassment on North Atlantic right whales, it is unlikely that the anticipated low-level exposures would lead to reduced reproductive success or survival.

North Atlantic right whales are listed as endangered under the ESA with a declining population primarily due to vessel strike and entanglement. Again, Revolution estimates that 44 instances of take, by Level B harassment only, could occur within the first year, and 56 instances of take could occur over the 5-year effective period of the proposed rule, with the likely scenario that each instance of exposure occurs to a different individual (a small portion of the stock), and any individual North Atlantic right whale is likely to be disturbed at a low-moderate level. The magnitude and severity of harassment are not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the proposed authorized take would have a negligible impact on the North Atlantic stock of North Atlantic right whales.

Humpback whales

Humpback whales potentially impacted by Revolution Wind's activities do not belong to a DPS that is listed as threatened or endangered under the ESA. However, humpback whales along the Atlantic Coast have been experiencing an active UME as elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through Florida since January 2016. Of the cases examined, approximately half had evidence of human interaction (ship strike or entanglement). The UME does not yet provide cause for concern regarding population-level impacts, and take from ship strike and entanglement is not proposed to be authorized. Despite the UME, the relevant population of humpback whales (the West Indies breeding population, or DPS of which the Gulf of Maine stock is a part) remains stable at approximately 12,000 individuals.

Revolution Wind has requested, and NMFS has proposed to authorize, a limited amount of humpback whale harassment, by Level A harassment and Level B harassment. No mortality or serious injury is anticipated or proposed for authorization. Among the activities analyzed, impact pile driving has the potential to result in the highest amount of annual take of humpback whales (7 takes by Level A harassment and 48 takes by Level B harassment) and is of greatest concern, given the associated loud source levels. Kraus *et al*. (2016) reported humpback whale sightings in the RI-MA WEA during all seasons, with peak abundance during the spring and early summer, but their presence within the region varies between years. Increased presence of sand lance (*Ammodytes* spp.) appears to correlate with the years in which most whales were observed, suggesting that humpback whale distribution and occurrence could largely be influenced by prey availability (Kenney and Vigness-Raposa 2010, 2016). Seasonal abundance estimates of humpback whales in the RI-MA WEA range from 0 to 41 (Kraus *et al*., 2016), with higher estimates observed during the spring and summer. Davis *et al.* (2020) found the greatest number of acoustic detections in southern New England in the winter and spring, with a noticeable decrease in acoustic detections during most summer and fall months. This data suggests that the 7 and 48 maximum annual instances of predicted to take by Level A harassment and Level B harassment, respectively, could consist of individuals exposed to noise levels above the harassment thresholds once during migration through the project area and/or individuals exposed on multiple days if they are utilizing the area as foraging habitat. Based on the observed peaks in humpback whale seasonal distribution in the RI/MA WEA, it is likely that these individuals would primarily be exposed to HRG survey activities, landfall construction activities, and to a lesser extent, impact pile driving and UXO/MEC detonations (given the seasonal restrictions on the latter two activities). Any such exposures would occur either singly, or intermittently, but not continuously throughout a day.

For all the reasons described in the Mysticete section above, we anticipate any potential PTS or TTS would be small (limited to a few dB) and concentrated at half or one octave above the frequency band of pile driving noise (most sound is below 2 kHz) which does not include the full predicted hearing range of baleen whales. If TTS is incurred, hearing sensitivity would likely return to pre-exposure levels shortly after exposure ends. Any masking or physiological responses would also be of low magnitude and severity for reasons described above.

Altogether, the amount of take proposed to be authorized is small, and the low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the proposed authorized take would have a negligible impact on the Gulf of Maine stock of humpback whales.

Fin whale

The western North Atlantic stock of fin whales is listed as endangered under the ESA. The 5-year total amount of take, by Level B harassment, of fin whales (n=48) NMFS proposes to authorize is low relative to the stock abundance. Any Level B harassment is expected to be in the form of behavioral disturbance, primarily resulting in avoidance of the project area where pile driving is occurring, and some low-level TTS and masking that may limit the detection of acoustic cues for relatively brief periods of time. No Level A harassment, serious injury, or mortality is anticipated or proposed for authorization. As described previously, the project area overlaps 11 percent of a small fin whale feeding BIA (March-October; 2,933 km^2) located east of Montauk Point, New York (Figure 2.3 in LaBrecque *et al.*, 2015). Although the RWF and a portion of the RWEC would be constructed within the fin whale foraging BIA, the BIA is considerably larger than the relatively small area within which impacts from monopile installations or UXO/MEC detonations may occur; this difference in scale would provide ample access to foraging opportunities for fin whales within the remaining area of the BIA. In addition, monopile installations and UXO/MEC detonations have seasonal/daily work restrictions, such that the temporal overlap between these project activities and the BIA timeframe does not include the months of March or April. Acoustic impacts from landfall construction would be limited to Narragansett Bay, within which fin whales are not expected to occur. A second larger yearlong feeding BIA (18,015 km^2) extends from the Great South Channel (east of the smaller fin whale feeding BIA) north to southern Maine. Any disruption of feeding behavior or avoidance of the western BIA by fin whales from May to October is expected to be temporary, with habitat utilization by fin whales returning to baseline once the construction activities cease. The larger fin whale feeding BIA would provide suitable alternate habitat and ample foraging opportunities consistently throughout the year, rather than seasonally like the smaller, western BIA.

Because of the relatively low magnitude and severity of take proposed for authorization, the fact that no serious injury or mortality is anticipated, the temporary nature of the disturbance, and the availability of similar habitat and resources in the surrounding area, NMFS has preliminarily determined that the impacts of Revolution Wind’s activities on fin whales and the food sources that they utilize are not expected to cause significant impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock.

Blue and Sei Whales

The Western North Atlantic stock of blue whales and the Nova Scotia stock of sei whales are also listed under the ESA. There are no known areas of specific biological importance in or around the project area, nor are there any UMEs. For both species, the actual abundance of each stock is likely significantly greater than what is reflected in each SAR because, as noted in the SARs, the most recent population estimates are primarily based on surveys conducted in U.S. waters and both stocks' range extends well beyond the U.S. Exclusive Economic Zone (EEZ).

The 5-year total amount of take, by Level B harassment, proposed for authorization for blue whales (n=7) and sei whales (n=26) is low, and no potential Level A harassment take is anticipated or proposed for authorization for either species. Similar to other mysticetes, we would anticipate the number of takes to represent individuals taken only once or, in rare cases, an individual taken a very small number of times as most whales in the project area would be migrating. To a small degree, sei whales may forage in the project area, although the currently identified foraging habitats (BIAs) are to the east and north of the area in which Revolution Wind's activities would occur (LaBrecque *et al.*, 2015). With respect to the severity of those individual takes by behavioral Level B harassment, we would anticipate impacts to be limited to low-level, temporary behavioral responses with avoidance and potential masking impacts in the vicinity of the turbine installation to be the most likely type of response. Any avoidance of the project area due to Revolution Wind's activities would be expected to be limited.

Overall, the take by harassment proposed for authorization is of a low magnitude and severity and is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the proposed authorized take would have a negligible impact on the Western North Atlantic blue whale stock and the Nova Scotia sei whale stock.

Minke Whales

The Canadian East Coast stock of minke whales is not listed under the ESA. There are no known areas of specific biological importance in or around the project area. Beginning in January 2017, elevated minke whale strandings have occurred along the Atlantic coast from Maine through South Carolina, with highest numbers in Massachusetts, Maine, and New York. This event does not provide cause for concern regarding population level impacts, as the likely population abundance is greater than 21,000 whales. No mortality or serious injury of this stock is anticipated or proposed for authorization.

Minke whales may be taken by Level B harassment; however, this would be limited to a relatively low number of individuals annually, with the maximum annual take of 304 minke whales estimated for the first year of construction and a maximum 320 across all 5 years. We anticipate the impacts of this harassment to follow those described in the general Mysticete section above. In summary, Level B harassment would be temporary, with primary impacts being temporary displacement of the project area but not abandonment of any migratory or foraging behavior. Overall, the amount of take proposed to be authorized is small and the low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the proposed authorized take would have a negligible impact on the Canadian East Coast stock of minke whales.

Odontocetes

In this section, we include information here that applies to all of the odontocete species and stocks addressed below, which are further divided into the following subsections: Sperm whales, Dolphins and small whales; and Harbor porpoises. These sub-sections include more specific information, as well as conclusions for each stock represented.

The majority of takes by harassment of odontocetes incidental to Revolution Wind's specified activities are by Level B harassment incidental to pile driving and HRG surveys. We anticipate that, given ranges of individuals (*i.e.*, that some individuals remain within a small area for some period of time), and non-migratory nature of some odontocetes in general (especially as compared to mysticetes), these takes are more likely to represent multiple exposures of a smaller number of individuals than is the case for mysticetes, though some takes may also represent one-time exposures to an individual.

Pile driving, particularly impact pile driving foundation piles, has the potential to disturb odontocetes to the greatest extent, compared to HRG surveys and UXO/MEC detonations. While we do expect animals to avoid the area during pile driving, their habitat range is extensive compared to the area ensonified during pile driving.

As described earlier, Level B harassment may manifest as changes to behavior (*e.g.*, avoidance, changes in vocalizations (from masking) or foraging), physiological responses, or TTS. Odontocetes are highly mobile species and, similar to mysticetes, NMFS expects any avoidance behavior to be limited to the area near the pile being driven. While masking could occur during pile driving, it would only occur in the vicinity of and during the duration of the pile driving, and would not generally occur in a frequency range that overlaps most odontocete communication or echolocation signals. The mitigation measures (*e.g.*, use of sound abatement systems, implementation of clearance and shutdown zones) would also minimize received levels such that the severity of any behavioral response would be expected to be less than exposure to unmitigated noise exposure.

Any masking or TTS effects are anticipated to be of low-severity. First, the frequency range of pile driving, the most impactful activity conducted by Revolution Wind in terms of response severity, falls within a portion of the frequency range of most odontocete vocalizations. However, odontocete vocalizations span a much wider range than the low frequency construction activities proposed by Revolution Wind. Further, as described above, recent studies suggest odontocetes have a mechanism to self-mitigate (*i.e.*, reduce hearing sensitivity) the impacts of noise exposure, which could potentially reduce TTS impacts. Any masking or TTS is anticipated to be limited and would typically only interfere with communication within a portion of an odontocete's range and as discussed earlier, the effects would only be expected to be of a short duration and, for TTS, a relatively small degree. Furthermore, odontocete echolocation occurs predominantly at frequencies significantly higher than low frequency construction activities; therefore, there is little likelihood that threshold shift, either temporary or permanent, would interfere with feeding behaviors (noting that take by Level A harassment (PTS) is proposed for only harbor porpoises). For HRG surveys, the sources operate at higher frequencies than pile driving and UXO/MEC detonations; however, sounds from these sources attenuate very quickly in the water column, as described above; therefore, any potential for TTS and masking is very limited. Further, odontocetes (*e.g.*, common dolphins, spotted dolphins, bottlenose dolphins) have demonstrated an affinity to bow-ride actively surveying HRG surveys; therefore, the severity of any harassment, if it does occur, is anticipated to be minimal based on the lack of avoidance previously demonstrated by these species.

The waters off the coast of Rhode Island are used by several odontocete species; however, none (except the sperm whale) are listed under the ESA and there are no known habitats of particular importance. In general, odontocete habitat ranges are far-reaching along the Atlantic coast of the U.S., and the waters off of Rhode Island, including the project area, do not contain any particularly unique odontocete habitat features.

Sperm Whale

The Western North Atlantic stock of sperm whales spans the East Coast out into oceanic waters well beyond the U.S. EEZ. Although listed as endangered, the primary threat faced by the sperm whale (*i.e.*, commercial whaling) has been eliminated and, further, sperm whales in the western North Atlantic were little affected by modern whaling (Taylor *et al*., 2008). Current potential threats to the species globally include vessel strikes, entanglement in fishing gear, anthropogenic noise, exposure to contaminants, climate change, and marine debris. There is no currently reported trend for the stock and, although the species is listed as endangered under the ESA, there are no specific issues with the status of the stock that cause particular concern (*e.g.*, no UMEs). There are no known areas of biological importance (*e.g.*, critical habitat or BIAs) in or near the project area.

No mortality, serious injury or Level A harassment is anticipated or proposed to be authorized for this species. Impacts would be limited to Level B harassment and would occur to only a very small number of individuals (maximum of 7 per year or 15 across all 5 years) incidental to pile driving, UXO/MEC detonation(s), and HRG surveys. Sperm whales are not common within the project area due to the shallow waters, and it is not expected that any noise levels would reach habitat in which sperm whales are common, including deep-water foraging habitat. If sperm whales do happen to be present in the project area during any activities related to the Revolution Wind project, they would likely be only transient visitors and not engaging in any significant behaviors. This very low magnitude and severity of effects is not expected to result in impacts on the reproduction or survival of individuals, much less impact annual rates of recruitment or survival. For these reasons, we have determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the take proposed to be authorized would have a negligible impact on sperm whales.

Dolphins and Small Whales (including delphinids, pilot whales, and harbor porpoises)

There are no specific issues with the status of odontocete stocks that cause particular concern (*e.g.,* no recent UMEs). No mortality or serious injury is expected or proposed to be authorized for these stocks. Only Level B harassment is anticipated or proposed for authorization for any dolphin or small whale.

The maximum amount of take, by Level B harassment, proposed for authorization within any one year for all odontocetes cetacean stocks ranges from 15 to 6,229 instances, which is less than a maximum of 3.6 percent as compared to the population size for all stocks. As described above for odontocetes broadly, we anticipate that a fair number of these instances of take in a day represent multiple exposures of a smaller number of individuals, meaning the actual number of individuals taken is lower. Although some amount of repeated exposures to some individuals is likely given the duration of activity proposed by Revolution Wind, the intensity of any Level B harassment combined with the availability of alternate nearby foraging habitat suggests that the likely impacts would not impact the reproduction or survival of any individuals.

Overall, the populations of all dolphins and small whale species and stocks for which we propose to authorize take are stable (no declining population trends), not facing existing UMEs, and the small amount, magnitude and severity of effects is not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the take proposed to be authorized would have a negligible impact on all dolphin and small whale species and stocks considered in this analysis.

Harbor Porpoises

The Gulf of Maine/Bay of Fundy stock of harbor porpoises is found predominantly in northern U.S. coastal waters (less than 150 m depth) and up into Canada's Bay of Fundy. Although the population trend is not known, there are no UMEs or other factors that cause particular concern for this stock. No mortality or non-auditory injury by UXO/MEC detonations are anticipated or authorized for this stock. NMFS proposes to authorize 49 takes by Level A harassment (PTS; incidental to UXO/MEC detonations) and 1,237 takes by Level B harassment (incidental to multiple activities).

Regarding the severity of takes by behavioral Level B harassment, because harbor porpoises are particularly sensitive to noise, it is likely that a fair number of the responses could be of a moderate nature, particularly to pile driving. In response to pile driving, harbor porpoises are likely to avoid the area during construction, as previously demonstrated in Tougaard *et al.* (2009) in Denmark, in Dahne *et al.* (2013) in Germany, and in Vallejo *et al.* (2017) in the United Kingdom, although a study by Graham *et al.* (2019) may indicate that the avoidance distance could decrease over time. However, pile driving is scheduled to occur when harbor porpoise abundance is low off the coast of Rhode Island and, given alternative foraging areas, any avoidance of the area by individuals is not likely to impact the reproduction or survival of any individuals. Given only one UXO/MEC would be detonated on any given day and up to only 13 UXO/MEC would be detonated over the 5-year effective period of the LOA, any behavioral response would be brief and of a low severity.

With respect to PTS and TTS, the effects on an individual are likely relatively low given the frequency bands of pile driving (most energy below 2 kHz) compared to harbor porpoise hearing (150 Hz to 160 kHz peaking around 40 kHz). Specifically, PTS or TTS is unlikely to impact hearing ability in their more sensitive hearing ranges, or the frequencies in which they communicate and echolocate. Regardless, we have authorized a limited amount of PTS, but expect any PTS that may occur to be within the very low end of their hearing range where harbor porpoises are not particularly sensitive, and any PTS would be of small magnitude. As such, any PTS would not interfere with key foraging or reproductive strategies necessary for reproduction or survival.

In summary, the amount of take proposed to be authorized (49 and 1,237 by Level A harassment and Level B harassment, respectively) is small and while harbor porpoises are likely to avoid the area during any construction activity discussed herein, as demonstrated during European wind farm construction, the time of year in which work would occur is when harbor porpoises are not in high abundance, and any work that does occur would not result in the species' abandonment of the waters off of Rhode Island. The low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Revolution Wind's activities combined, that the proposed authorized take would have a negligible impact on the Gulf of Maine/Bay of Fundy stock of harbor porpoises.

Pinnipeds (Harbor seals and gray seals)

Neither the harbor seal nor gray seal are listed under the ESA. Revolution Wind requested, and NMFS proposes to authorize that no more than 16 and 2,393 harbor seals and 7 and 978 gray seals may be taken by Level A harassment and Level B harassment, respectively, within any one year. These species occur in Rhode Island waters most often in winter, when impact pile driving and UXO/MEC detonations would not occur. Seals are also more likely to be close to shore such that exposure to impact pile driving would be expected to be at lower levels generally (but still above NMFS behavioral harassment threshold). The majority of takes of these species is from monopile installations, vibratory pile driving associated with temporary cofferdam installation and removal, and HRG surveys. Research and observations show that pinnipeds in the water may be tolerant of anthropogenic noise and activity (a review of behavioral reactions by pinnipeds to impulsive and non-impulsive noise can be found in Richardson *et al.* (1995) and Southall *et al.* (2007)). Available data, though limited, suggest that exposures between approximately 90 and 140 dB SPL do not appear to induce strong behavioral responses in pinnipeds exposed to non-pulse sounds in water (Costa *et al.,* 2003; Jacobs and Terhune, 2002; Kastelein *et al.,* 2006c). Although there was no significant displacement during construction as a whole, Russell *et al*. (2016) found that displacement did occur during active pile driving at predicted received levels between 168 and 178 dB re 1μPa$_{(p\text{-}p)}$; however seal distribution returned to the pre-piling condition within two hours of cessation of pile driving. Pinnipeds may not react at all until the sound source is approaching (or they approach the sound source) within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Effects on pinnipeds that are taken by Level B harassment in the project area would likely be limited to reactions such as increased swimming speeds, increased surfacing time, or decreased foraging (if such activity were occurring). Most likely, individuals would simply move away from the sound source and be temporarily displaced from those areas (see Lucke *et al*., 2006; Edren *et al*., 2010; Skeate *et al*., 2012; Russell *et al*., 2016). Given their documented tolerance of anthropogenic sound (Richardson *et al.,* 1995; Southall *et al.,* 2007), repeated exposures of individuals of either of these species to levels of sound that may cause Level B harassment are unlikely to significantly disrupt foraging behavior. Given the low anticipated magnitude of impacts from any given exposure, even repeated Level B harassment across a few days of some small subset of individuals, which could occur, is unlikely to result in impacts on the reproduction or survival of any individuals.

Moreover, pinnipeds would benefit from the mitigation measures described in the **Proposed Mitigation** section.

Revolution Wind requested, and NMFS is proposing to authorize, a small amount of PTS (16 harbor seals and 7 gray seals which constitutes less than 0.1 percent of each population) incidental to UXO/MEC detonation. As described above, noise from UXO/MEC detonation is low frequency and, while any PTS that does occur would fall within the lower end of pinniped hearing ranges (50 Hz to 86 kHz), PTS would not occur at frequencies where pinniped hearing is most sensitive. In summary, any PTS, would be of small degree and not occur across the entire, or even most sensitive, hearing range. Hence, any impacts from PTS are likely to be of low severity and not interfere with behaviors critical to reproduction or survival.

Elevated numbers of harbor seal and gray seal mortalities were first observed in July 2018 and occurred across Maine, New Hampshire, and Massachusetts until 2020. Based on tests conducted so far, the main pathogen found in the seals belonging to that UME was phocine distemper virus, although additional testing to identify other factors that may be involved in this UME are underway. Currently, the only active UME is occurring in Maine with some harbor and gray seals testing positive for highly pathogenic avian influenza (HPAI) H5N1. Although elevated strandings continue, neither UME (alone or in combination) provide cause for concern regarding population-level impacts to any of these stocks. For harbor seals, the population abundance is over 75,000 and annual M/SI (350) is well below PBR (2,006) (Hayes *et al*., 2020). The population abundance for gray seals in the United States is over 27,000, with an estimated overall abundance, including seals in Canada, of approximately 450,000. In addition, the abundance of gray seals is likely increasing in the U.S. Atlantic, as well as in Canada (Hayes *et al.*, 2020).

Overall, impacts from the Level B harassment take proposed for authorization incidental to Revolution Wind's specified activities would be of relatively low magnitude and a low severity. Similarly, while some individuals may incur PTS overlapping some frequencies that are used for foraging and communication, given the low degree, the impacts would not be expected to impact reproduction or survival of any individuals. In consideration of all of the effects of Revolution Wind's activities combined, we have preliminarily determined that the authorized take will have a negligible impact on harbor seals and gray seals.

Preliminary Negligible Impact Determination

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the marine mammal take from all of Revolution Wind's specified activities combined will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under sections 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. When the predicted number of individuals to be taken is less than one-third of the species or stock abundance, the take is considered to be of small numbers. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

NMFS proposes to authorize incidental take (by Level A harassment and Level B harassment) of 16 species of marine mammal (with 16 managed stocks). The maximum number of takes possible within any one year and proposed for authorization relative to the best available population abundance is low for all species and stocks potentially impacted (*i.e.*, less than 1 percent for nine stocks, less than 4 percent for five stocks, and less than 12 percent for two stocks; see Table 33). Therefore, NMFS preliminarily finds that small numbers of marine mammals may be taken relative to the estimated overall population abundances for those stocks.

Based on the analysis contained herein of the proposed action (including the proposed mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals would be taken relative to the population size of the affected species or stocks.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act (ESA)

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA: 16 U.S.C. 1531 *et seq*.) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the promulgation of rulemakings, NMFS consults internally whenever we propose to authorize take for endangered or threatened species, in this case with the NMFS Greater Atlantic Regional Field Office (GARFO).

NMFS is proposing to authorize the take of five marine mammal species which are listed under the ESA: the North Atlantic right, sei, fin, blue, and sperm whale. The Permit and Conservation Division requested initiation of Section 7 consultation on November 1, 2022 with GARFO for the issuance of this proposed rulemaking. NMFS will conclude the Endangered Species Act consultation prior to reaching a determination regarding the proposed issuance of the authorization. The proposed regulations and any subsequent LOA(s) would be conditioned such that, in addition to measures included in those documents, the applicant would also be required to abide by the reasonable and prudent measures and terms and conditions of a Biological Opinion and Incidental Take Statement, issued by NMFS, pursuant to Section 7 of the Endangered Species Act.

Proposed Promulgation

As a result of these preliminary determinations, NMFS proposes to promulgate an ITA for Revolution Wind authorizing take, by Level A and B harassment, incidental to construction activities associated with the Revolution Wind Offshore Wind Farm project offshore of Rhode Island for a 5-year period from October 5, 2023 through October 4, 2028, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed rulemaking can be found at *https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy*.

Request for Additional Information and Public Comments

NMFS requests interested persons to submit comments, information, and suggestions concerning Revolution Wind's request and the proposed regulations (see **ADDRESSES**). All comments will be reviewed and evaluated as we prepare the final rule and make final determinations on whether to issue the requested authorization. This notice and referenced documents provide all environmental information relating to our proposed action for public review.

Recognizing, as a general matter, that this action is one of many current and future wind energy actions, we invite comment on the relative merits of the IHA, single-action rule/LOA, and programmatic multi-action rule/LOA approaches, including potential marine mammal take impacts resulting from this and other related wind energy actions and possible benefits resulting from regulatory certainty and efficiency.

Classification

Pursuant to the procedures established to implement Executive Order 12866, the Office of Management and Budget has determined that this proposed rule is not significant.

Pursuant to section 605(b) of the Regulatory Flexibility Act (RFA), the Chief Counsel for Regulation of the Department of Commerce has certified to the Chief Counsel for Advocacy of the Small Business Administration that this proposed rule, if adopted, would not have a significant economic impact on a substantial number of small entities. Revolution Wind is the sole entity that would be subject to the requirements in these proposed regulations, and Revolution Wind is not a small governmental jurisdiction, small organization, or small business, as defined by the RFA. Under the RFA, governmental jurisdictions are considered to be small if they are governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than 50,000. Because of this certification, a regulatory flexibility analysis is not required and none has been prepared.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act (PRA) unless that collection of information displays a currently valid Office of Management and Budget (OMB) control number. These requirements have been approved by OMB under control number 0648-0151 and include applications for regulations, subsequent LOA, and reports. Send comments regarding any aspect of this data collection, including suggestions for reducing the burden, to NMFS.

The Coastal Zone Management Act (CZMA) requires Federal actions within and outside the coastal zone that have reasonably foreseeable effects on any coastal use or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program. 16 U.S.C. 1456(c). Additionally, regulations implementing the CZMA require non-Federal applicants for Federal licenses or permits to submit a consistency certification to the state that declares that the proposed activity complies with the enforceable policies of the state's approved management program and will be conducted in a manner consistent with such program. As required, on June 7, 2021, Revolution Wind submitted a Federal consistency certification to the Commonwealth of Massachusetts Office of Coastal Zone Management and the State of Rhode Island Coastal Resources Management Council for approval of the Construction and Operations Plan (COP) by BOEM and the issuance of an Individual Permit by United States Army Corps of Engineers, under section 10 and 14 of the Rivers and Harbors Act and section 404 of the Clean Water Act (15 CFR part 930, subpart E). The Commonwealth of Massachusetts issued its concurrence on October 7, 2022, and the State of Rhode Island issued its concurrence on December 21, 2022.

NMFS has determined that Revolution Wind's application for an authorization to allow the incidental, but not intentional, take of small numbers of marine mammals on the outer continental shelf is an unlisted activity and, thus, is not, at this time, subject to Federal consistency requirements in the absence of the receipt and prior approval of an unlisted activity review request from the state by the Director of NOAA's Office for Coastal Management.

List of Subjects in 50 CFR Part 217

Administrative practice and procedure, Endangered and threatened species, Exports, Fish, Fisheries, Marine mammals, Penalties, Reporting and recordkeeping requirements, Seafood, Transportation, Wildlife.

Dated: December 14, 2022.

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Andrew James Strelcheck

Acting Deputy Assistant Administrator for Regulatory Programs,

National Marine Fisheries Service.

For reasons set forth in the preamble, 50 CFR part 217 is proposed to be amended as follows:

PART 217 – REGULATIONS GOVERNING THE TAKING AND IMPORTING OF MARINE MAMMALS

1. The authority citation for part 217 continues to read as follows:

Authority: 16 U.S.C. 1361 *et seq*., unless otherwise noted.

2. Add subpart BB, consisting of §§ 217.270 through 217.279, to read as follows:

Subpart BB – Taking Marine Mammals Incidental to the Revolution Wind Offshore Wind Farm Project Offshore Rhode Island

Sec.

217.270 Specified activity and specified geographical region.

217.271 Effective dates.

217.272 Permissible methods of taking.

217.273 Prohibitions.

217.274 Mitigation requirements.

217.275 Requirements for monitoring and reporting.

Subpart BB – Taking Marine Mammals Incidental to the Revolution Wind Offshore Wind Farm Project Offshore Rhode Island

§ 217.270 Specified activity and specified geographical region.

(a) Regulations in this subpart apply only to the taking of marine mammals that occurs incidental to activities associated with construction of the Revolution Wind Offshore Wind Farm Project by Revolution Wind, LLC (Revolution Wind) and those persons it authorizes or funds to conduct activities on its behalf in the area outlined in paragraph (b) of this section.

(b) The taking of marine mammals by Revolution Wind may be authorized in a Letter of Authorization (LOA) only if it occurs in the Bureau of Ocean Energy Management (BOEM) lease area Outer Continental Shelf (OCS)-A-0486 Commercial Lease of Submerged Lands for Renewable Energy Development and along export cable route at sea-to-shore transition points at Quonset Point in North Kingstown, Rhode Island.

(c) The taking of marine mammals by Revolution Wind is only authorized if it occurs incidental to the following activities associated with the Revolution Wind Offshore Wind Farm Project:

(1) Installation of wind turbine generators (WTG) and offshore substation (OSS) foundations by impact pile driving;

(2) Installation of temporary cofferdams by vibratory pile driving;

(3) High-resolution geophysical (HRG) site characterization surveys; and,

(4) Detonation of unexploded ordnances (UXOs) or munitions and explosives of concern (MECs).

§ 217.271 Effective dates.

Regulations in this subpart are effective from October 5, 2023, through October 4 31, 2028.

§ 217.272 Permissible methods of taking.

Under an LOA, issued pursuant to §§ 216.106 and 217.276, Revolution Wind, and those persons it authorizes or funds to conduct activities on its behalf, may incidentally, but not intentionally, take marine mammals within the area described in § 217.270(b) in the following ways, provided Revolution Wind is in complete compliance with all terms, conditions, and requirements of the regulations in this subpart and the appropriate LOA:

(a) By Level B harassment associated with the acoustic disturbance of marine mammals by impact pile driving (WTG and OSS monopile foundation installation), vibratory pile installation and removal of temporary cofferdams, the detonation of UXOs/MECs, and through HRG site characterization surveys.

(b) By Level A harassment, provided take is associated with impact pile driving and UXO/MEC detonations.

(c) The incidental take of marine mammals by the activities listed in paragraphs (a) and (b) of this section is limited to the following species:

Table 1 to Paragraph (c)

Marine Mammal Species	Scientific Name	Stock
Blue whale	*Balaenoptera musculus*	Western North Atlantic
Fin whale	*Balaenoptera physalus*	Western North Atlantic
Sei whale	*Balaenoptera borealis*	Nova Scotia
Minke whale	*Balaenoptera acutorostrata*	Canadian East Stock

North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine
Sperm whale	*Physeter macrocephalus*	North Atlantic
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic
Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore
Common dolphin	*Delphinus delphis*	Western North Atlantic
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic
Risso's dolphin	*Grampus griseus*	Western North Atlantic
Gray seal	*Halichoerus grypus*	Western North Atlantic
Harbor seal	*Phoca vitulina*	Western North Atlantic

§ 217.273 Prohibitions.

Except for the takings described in § 217.272 and authorized by an LOA issued under § 217.276 or § 217.277, it is unlawful for any person to do any of the following in connection with the activities described in this subpart:

(a) Violate, or fail to comply with, the terms, conditions, and requirements of this subpart or an LOA issued under §§ 217.276 and 217.277;

(b) Take any marine mammal not specified in § 217.272(c);

(c) Take any marine mammal specified in the LOA in any manner other than as specified in the LOA; or

(d) Take any marine mammal, as specified in § 217.272(c), after NMFS determines such taking results in more than a negligible impact on the species or stocks of such marine mammals.

§ 217.274 Mitigation requirements.

When conducting the activities identified in §§ 217.270(a) and 217.272, Revolution Wind must implement the mitigation measures contained in this section and any LOA issued under § 217.276 or § 217.277. These mitigation measures must include, but are not limited to:

(a) *General conditions*. (1) A copy of any issued LOA must be in the possession of Revolution Wind and its designees, all vessel operators, visual protected species observers (PSOs), passive acoustic monitoring (PAM) operators, pile driver operators, and any other relevant designees operating under the authority of the issued LOA;

(2) Revolution Wind must conduct briefings between construction supervisors, construction crews, and the PSO and PAM team prior to the start of all construction activities, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring and reporting protocols, and operational procedures. An informal guide must be included with the Marine Mammal Monitoring Plan to aid personnel in identifying species if they are observed in the vicinity of the project area;

(3) Revolution Wind must instruct all vessel personnel regarding the authority of the PSO(s). For example, the vessel operator(s) would be required to immediately comply with any call for a shutdown by the Lead PSO. Any disagreement between the Lead PSO and the vessel operator would only be discussed after shutdown has occurred;

(4) Revolution Wind must ensure that any visual observations of an ESA-listed marine mammal are communicated to PSOs and vessel captains during the concurrent use

of multiple project-associated vessels (of any size; *e.g.,* construction surveys, crew/supply transfers, etc.);

(5) If an individual from a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized take number has been met, is observed entering or within the relevant Level B harassment zone for each specified activity, pile driving and pneumatic hammering activities, and HRG acoustic sources must be shut down immediately, unless shutdown is not practicable, or be delayed if the activity has not commenced. Impact and vibratory pile driving, pneumatic hammering, UXO/MEC detonation, and initiation of HRG acoustic sources must not commence or resume until the animal(s) has been confirmed to have left the relevant clearance zone or the observation time has elapsed with no further sightings. UXO/MEC detonations may not occur until the animal(s) has been confirmed to have left the relevant clearance zone or the observation time has elapsed with no further sightings;

(6) Prior to and when conducting any in-water construction activities and vessel operations, Revolution Wind personnel (*e.g.*, vessel operators, PSOs) must use available sources of information on North Atlantic right whale presence in or near the project area including daily monitoring of the Right Whale Sightings Advisory System, and monitoring of Coast Guard VHF Channel 16 throughout the day to receive notification of any sightings and/or information associated with any slow zones (*i.e.*, Dynamic Management Areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for both vessel operators and PSOs; and

(7) Any marine mammals observed within a clearance or shutdown zone must be allowed to remain in the area (*i.e.*, must leave of their own volition) prior to commencing impact and vibratory pile driving activities, pneumatic hammering, or HRG surveys.

(8) Revolution Wind must treat any large whale sighted by a PSO or acoustically detected by a PAM operator as if it were a North Atlantic right whale, unless a PSO or a PAM operator confirms it is another type of whale.

(b) *Vessel strike avoidance measures*. (1) Prior to the start of construction activities, all vessel operators and crew must receive a protected species identification training that covers, at a minimum:

(i) Sightings of marine mammals and other protected species known to occur or which have the potential to occur in the Revolution Wind project area;

(ii) Training on making observations in both good weather conditions (*i.e.*, clear visibility, low winds, low sea states) and bad weather conditions (*i.e.*, fog, high winds, high sea states, with glare);

(iii) Training on information and resources available to the project personnel regarding the applicability of Federal laws and regulations for protected species;

(iv) Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities; and

(v) Confirmation of marine mammal observer training (including an understanding of the LOA requirements) must be documented on a training course log sheet and reported to NMFS.

(2) All vessels must abide by the following:

(i) All vessel operators and crews, regardless of their vessel's size, must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate, to avoid striking any marine mammal;

(ii) All vessels must have a visual observer on board who is responsible for monitoring the vessel strike avoidance zone for marine mammals. Visual observers may be PSO or crew members, but crew members responsible for these duties must be provided sufficient training by Revolution Wind to distinguish marine mammals from other phenomena and must be able to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Crew members serving as visual observers must not have duties other than observing for marine mammals while the vessel is operating over 10 knots (kns);

(iii) Year-round and when a vessel is in transit, all vessel operators must continuously monitor U.S. Coast Guard VHF Channel 16, over which North Atlantic right whale sightings are broadcasted. At the onset of transiting and at least once every four hours, vessel operators and/or trained crew members must monitor the project's Situational Awareness System, WhaleAlert, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales Any observations of any large whale by any Revolution Wind staff or contractors, including vessel crew, must be communicated immediately to PSOs, PAM operator, and all vessel captains to increase situational awareness. Conversely, any large whale observation or detection via a sighting network (*e.g.*, Mysticetus) by PSOs or PAM operators must be conveyed to vessel operators and crew;

(iv) Any observations of any large whale by any Revolution Wind staff or contractor, including vessel crew, must be communicated immediately to PSOs and all vessel captains to increase situational awareness;

(v) All vessels must comply with existing NMFS vessel speed regulations in 50 CFR 224.105, as applicable, for North Atlantic right whales;

(vi) In the event that any slow zone (designated as a DMA) is established that overlaps with an area where a project-associated vessel would operate, that vessel, regardless of size, will transit that area at 10 kns or less;

(vii) Between November 1st and April 30th, all vessels, regardless of size, would operate port to port (specifically from ports in New Jersey, New York, Maryland, Delaware, and Virginia) at 10 kns or less, except for vessels while transiting in Narragansett Bay or Long Island Sound which have not been demonstrated by best available science to provide consistent habitat for North Atlantic right whales;

(viii) All vessels, regardless of size, must immediately reduce speed to 10 kns or less when any large whale, mother/calf pairs, or large assemblages of non-delphinid cetaceans are observed (within 500 m) of an underway vessel;

(ix) All vessels, regardless of size, must immediately reduce speed to 10 kns or less when a North Atlantic right whale is sighted, at any distance, by anyone on the vessel;

(x) If a vessel is traveling at greater than 10 kns, in addition to the required dedicated visual observer, Revolution Wind must monitor the transit corridor in real-time with PAM prior to and during transits. If a North Atlantic right whale is detected via visual observation or PAM within or approaching the transit corridor, all crew transfer vessels must travel at 10 kns or less for 12 hours following the detection. Each subsequent detection triggers an additional 12-hour period at 10 kns or less. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor for 12 hours;

(xi) All underway vessels (*e.g.*, transiting, surveying) operating at any speed must have a dedicated visual observer on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard) located at an appropriate vantage point for ensuring vessels are maintaining appropriate separation distances. Visual observers must be equipped with alternative monitoring technology for periods of low visibility (*e.g.*, darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements in this proposed action. Visual observers may be third-party observers (*i.e.*, NMFS-approved PSOs) or crew members. Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities;

(xii) All vessels must maintain a minimum separation distance of 500 m from North Atlantic right whales. If underway, all vessels must steer a course away from any sighted North Atlantic right whale at 10 kns or less such that the 500-m minimum separation distance requirement is not violated. If a North Atlantic right whale is sighted within 500 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take the vessel strike avoidance measures described in this paragraph (b)(2)(xii);

(xiii) All vessels must maintain a minimum separation distance of 100 m from sperm whales and baleen whales other than North Atlantic right whales. If one of these species is sighted within 100 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 100 m;

(xiv) All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all delphinoid cetaceans and pinnipeds, with an exception made for those that approach the vessel (*e.g.*, bow-riding dolphins). If a delphinid cetacean or pinniped is sighted within 50 m of an underway vessel, that vessel must shift the engine to neutral, with an exception made for those that approach the vessel (*e.g.*, bow-riding dolphins). Engines must not be engaged until the animal(s) has moved outside of the vessel's path and beyond 50 m;

(xv) When a marine mammal(s) is sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distances (*e.g.*, attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If a marine mammal(s) is sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engine(s) until the animal(s) is clear of the area. This does not apply to any vessel towing gear or any situation where respecting the relevant separation distance would be unsafe (*i.e.*, any situation where the vessel is navigationally constrained);

(xvi) All vessels underway must not divert or alter course to approach any marine mammal. Any vessel underway must avoid speed over 10 kns or abrupt changes in course direction until the animal is out of an on a path away from the separation distances;

(xvii) For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal is on a path towards or comes within 10 m of equipment, Revolution Wind must cease operations until the marine mammal has moved more than 10 m on a path away from the activity to avoid direct interaction with equipment; and

(xviii) Revolution Wind must submit a North Atlantic right whale vessel strike avoidance plan 90 days prior to commencement of vessel use. The plan will, at minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of right whales. The plan will also provide details on the vessel-based observer protocols on transiting vessels.

(c) *Fisheries monitoring surveys*—(1) *Training*. (i) All crew undertaking the fishery survey activities must receive protected species identification training prior to activities occurring.

(ii) [Reserved]

(2) *During vessel use*. (i) Marine mammal monitoring must occur prior to, during, and after haul-back, and gear must not be deployed if a marine mammal is observed in the area;

(ii) Trawl operations must only start after 15 minutes of no marine mammal sightings within 1 nautical mile (nmi) of the sampling station; and

(iii) During daytime sampling for the research trawl surveys, Revolution Wind must maintain visual monitoring efforts during the entire period of time that trawl gear is in the water from deployment to retrieval. If a marine mammal is sighted before the gear is removed from the water, the vessel must slow its speed and steer away from the observed animal(s).

(3) *Gear-specific best management practices (BMPs)*. (i) Research trawl bottom times must be limited to 20 minutes;

(ii) Ventless trap surveys must utilize sinking ground lines and all lines will have breaking strength of less than 1,700 pounds and sinking groundlines. Sampling gear must be hauled at least once every 30 days, and the gear must be removed from the water at the end of each sampling season;

(iii) The permit number must be written clearly on buoy and any lines that go missing must be reported to NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO) Protected Resources Division as soon as possible;

(iv) If marine mammals are sighted near the proposed sampling location, trawl or ventless trap gear must be delayed until the marine mammal(s) has left the area;

(v) If a marine mammal is determined to be at risk of interaction with the deployed gear, all gear must be immediately removed;

(vi) Marine mammal monitoring must occur during daylight hours and begin prior to the deployment of any gear (*e.g.*, trawls) and continue until all gear has been retrieved; and

(vii) If marine mammals are sighted in the vicinity within 15 minutes prior to gear deployment and it is determined the risks of interaction are present regarding the research gear, the sampling station must either be moved to another location or activities must be suspended until there are no marine mammal sightings for 15 minutes within 1 nm.

(d) *Wind turbine generator (WTG) and offshore substation (OSS) foundation installation*—(1) *Seasonal and daily restrictions*. (i) Foundation impact pile driving activities may not occur January 1 through April 30;

(ii) No more than three foundation monopiles may be installed per day;

(iii) Revolution Wind must not initiate pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset, unless Revolution Wind submits and NMFS approves an Alternative Monitoring Plan as part of the Pile Driving and Marine Mammal Monitoring Plan that reliably demonstrates the efficacy of their night vision devices; and

(iv) Monopiles must be no larger than 15 m in diameter, representing the larger end of the tapered 7/15 m monopile design. The minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Maximum hammer energies must not exceed 4,000 kilojoules (kJ).

(2) *Noise abatement systems.* (i) Revolution Wind must deploy dual noise abatement systems that are capable of achieving, at a minimum, 10-dB of sound attenuation, during all impact pile driving of foundation piles:

(A) A single big bubble curtain (BBC) must not be used unless paired with another noise attenuation device; and

(B) A double big bubble curtain (dBBC) may be used without being paired with another noise attenuation device;

(ii) The bubble curtain(s) must distribute air bubbles using an air flow rate of at least 0.5 $m^3/(min*m)$. The bubble curtain(s) must surround 100 percent of the piling perimeter throughout the full depth of the water column. In the unforeseen event of a single compressor malfunction, the offshore personnel operating the bubble curtain(s) must make appropriate adjustments to the air supply and operating pressure such that the maximum possible sound attenuation performance of the bubble curtain(s) is achieved;

(iii) The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100-percent seafloor contact;

(iv) No parts of the ring or other objects may prevent full seafloor contact; and

(v) Construction contractors must train personnel in the proper balancing of airflow to the ring. Construction contractors must submit an inspection/performance report for approval by Revolution Wind within 72 hours following the performance test. Corrections to the bubble ring(s) to meet the performance standards in this paragraph (d)(2) must occur prior to impact pile driving of monopiles. If Revolution Wind uses a noise mitigation device in addition to the BBC, Revolution Wind must maintain similar quality control measures as described in this paragraph (d)(2).

(3) *Sound field verification*. (i) Revolution Wind must perform sound field verification (SFV) during all impact pile driving of the first three monopiles and must empirically determine source levels (peak and cumulative sound exposure level), the ranges to the isopleths corresponding to the Level A harassment (permanent threshold

shift (PTS)) and Level B harassment thresholds, and estimated transmission loss coefficients;

(ii) If a subsequent monopile installation location is selected that was not represented by previous three locations (*i.e.*, substrate composition, water depth), SFV must be conducted;

(iii) Revolution Wind may estimate ranges to the Level A harassment and Level B harassment isopleths by extrapolating from in situ measurements conducted at several distances from the monopiles, and must measure received levels at a standard distance of 750 m from the monopiles;

(iv) If SFV measurements on any of the first three piles indicate that the ranges to Level A harassment and Level B harassment isopleths are larger than those modeled, assuming 10-dB attenuation, Revolution Wind must modify and/or apply additional noise attenuation measures (*e.g.*, improve efficiency of bubble curtain(s), modify the piling schedule to reduce the source sound, install an additional noise attenuation device) before the second pile is installed. Until SFV confirms the ranges to Level A harassment and Level B harassment isopleths are less than or equal to those modeled, assuming 10-dB attenuation, the shutdown and clearance zones must be expanded to match the ranges to the Level A harassment and Level B harassment isopleths based on the SFV measurements. If the application/use of additional noise attenuation measures still does not achieve ranges less than or equal to those modeled, assuming 10-dB attenuation, and no other actions can further reduce sound levels, Revolution Wind must expand the clearance and shutdown zones according to those identified through SFV, in consultation with NMFS;

(v) If harassment zones are expanded beyond an additional 1,500 m, additional PSOs must be deployed on additional platforms, with each observer responsible for maintaining watch in no more than 180° and of an area with a radius no greater than 1,500 m;

(vi) If acoustic measurements indicate that ranges to isopleths corresponding to the Level A harassment and Level B harassment thresholds are less than the ranges predicted by modeling (assuming 10-dB attenuation), Revolution Wind may request a modification of the clearance and shutdown zones for impact pile driving of monopiles and UXO/MEC detonations. For a modification request to be considered by NMFS, Revolution Wind must have conducted SFV on three or more monopiles and on all detonated UXOs/MECs thus far to verify that zone sizes are consistently smaller than predicted by modeling (assuming 10-dB attenuation). Regardless of SFV measurements, the clearance and shutdown zones for North Atlantic right whales must not be decreased;

(vii) If a subsequent monopile installation location is selected that was not represented by previous locations (*i.e.*, substrate composition, water depth), SFV must be conducted. If a subsequent UXO/MEC charge weight is encountered and/or detonation location is selected that was not representative of the previous locations (*i.e.*, substrate composition, water depth), SFV must be conducted;

(viii) Revolution Wind must submit a SFV Plan at least 180 days prior to the planned start of impact pile driving and any UXO/MEC detonation activities. The plan must describe how Revolution Wind would ensure that the first three monopile foundation installation sites selected and each UXO/MEC detonation scenario (*i.e.*, charge weight, location) selected for SFV are representative of the rest of the monopile installation sites and UXO/MEC scenarios. In the case that these sites/scenarios are not determined to be representative of all other monopile installation sites and UXO/MEC detonations, Revolution Wind must include information on how additional sites/scenarios would be selected for SFV. The plan must also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. Revolution Wind must also provide, as soon as they are available but no later than 48 hours after each installation, the initial results of the SFV measurements to NMFS in an interim report after each monopile for the first three piles and after each UXO/MEC detonation; and

(ix) The SFV plan must also include how operational noise would be monitored. Revolution Wind must estimate source levels (at 10 m from the operating foundation) based on received levels measured at 50 m, 100 m, and 250 m from the pile foundation. These data must be used to identify estimated transmission loss rates. Operational parameters (*e.g.*, direct drive/gearbox information, turbine rotation rate) as well as sea state conditions and information on nearby anthropogenic activities (*e.g.*, vessels transiting or operating in the area) must be reported.

(4) *Protected species observer and passive acoustic monitoring use*. (i) Revolution Wind must have a minimum of four PSOs actively observing marine mammals before, during, and after (specific times described in this paragraph (d)(4)) the installation of monopiles. At least four PSOs must be actively observing for marine mammals. At least two PSOs must be actively observing on the pile driving vessel while at least two PSOs must be actively observing on a secondary, PSO-dedicated vessel. At least one active PSO on each platform must have a minimum of 90 days at-sea experience working in those roles in offshore environments with no more than eighteen months elapsed since the conclusion of the at-sea experience. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals before, during and after impact pile driving with PAM; and

(ii) All visual PSOs and PAM operators used for the Revolution Wind project must meet the requirements and qualifications described in § 217.275(a) and (b), and (c), respectively, and as applicable to the specified activity.

(5) *Clearance and shutdown zones*. (i) Revolution Wind must establish and implement clearance and shutdown zones (all distances to the perimeter are the radii from the center of the pile being driven) as described in the LOA for all WTG and OSS foundation installation;

(ii) Revolution Wind must use visual PSOs and PAM operators to monitor the area around each foundation pile before, during and after pile driving. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes prior to commencing pile driving. At least one PAM operator must review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be visually confirmed to be free of marine mammals for 30 minutes immediately prior to starting a soft-start of pile driving;

(iii) PSOs must be able to visually clear (*i.e.*, confirm no marine mammals are present) an area that extends around the pile being driven as described in the LOA. The entire minimum visibility zone must be visible (*i.e.*, not obscured by dark, rain, fog, etc.) for a full 30 minutes immediately prior to commencing impact pile driving (minimum visibility zone size dependent on season);

(iv) If a marine mammal is observed entering or within the relevant clearance zone prior to the initiation of impact pile driving activities, pile driving must be delayed and must not begin until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other marine mammal species;

(v) The clearance zone may only be declared clear if no confirmed North Atlantic right whale acoustic detections (in addition to visual) have occurred within the PAM clearance zone during the 60-minute monitoring period. Any large whale sighting by a PSO or detected by a PAM operator that cannot be identified by species must be treated as if it were a North Atlantic right whale;

(vi) If a marine mammal is observed entering or within the respective shutdown zone, as defined in the LOA, after impact pile driving has begun, the PSO must call for a temporary shutdown of impact pile driving;

(vii) Revolution Wind must immediately cease pile driving if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual, pile refusal, or pile instability. In this situation, Revolution Wind must reduce hammer energy to the lowest level practicable;

(viii) Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other marine mammal species. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Revolution Wind must use the lowest hammer energy practicable to maintain stability;

(ix) If impact pile driving has been shut down due to the presence of a North Atlantic right whale, pile driving may not restart until the North Atlantic right whale is no longer observed or 30 minutes has elapsed since the last detection; and

(x) Upon re-starting pile driving, soft start protocols must be followed.

(6) *Soft start*. (i) Revolution Wind must utilize a soft start protocol for impact pile driving of monopiles by performing 4-6 strikes per minute at 10 to 20 percent of the maximum hammer energy, for a minimum of 20 minutes;

(ii) Soft start must occur at the beginning of monopile installation and at any time following a cessation of impact pile driving of 30 minutes or longer; and

(iii) If a marine mammal is detected within or about to enter the applicable clearance zones, prior to the beginning of soft-start procedures, impact pile driving must be delayed until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other species.

(e) *Cofferdam or casing pipe installation*—(1) *Daily restrictions*. (i) Revolution Wind must conduct vibratory pile driving or pneumatic hammering during daylight hours only.

(ii) [Reserved]

(2) *PSO use*. (i) All visual PSOs used for the Revolution Wind project must meet the requirements and qualifications described in § 217.275(a) and (b), as applicable to the specified activity; and

(ii) Revolution Wind must have a minimum of two PSOs on active duty during any installation and removal of the temporary cofferdams, or casing pipes and goal posts. These PSOs would always be located at the best vantage point(s) on the vibratory pile driving platform or secondary platform in the immediate vicinity of the vibratory pile driving platform, in order to ensure that appropriate visual coverage is available for the entire visual clearance zone and as much of the Level B harassment zone, as possible.

(3) *Clearance and shutdown zones*. (i) Revolution Wind must establish and implement clearance and shutdown zones as described in the LOA;

(ii) Prior to the start of pneumatic hammering or vibratory pile driving activities, at least two PSOs must monitor the clearance zone for 30 minutes, continue monitoring during pile driving and for 30 minutes post pile driving;

(iii) If a marine mammal is observed entering or is observed within the clearance zones, piling and hammering must not commence until the animal has exited the zone or a specific amount of time has elapsed since the last sighting. The specific amount of time is 30 minutes for large whales and 15 minutes for dolphins, porpoises, and pinnipeds;

(iv) If a marine mammal is observed entering or within the respective shutdown zone, as defined in the LOA, after vibratory pile driving or hammering has begun, the PSO must call for a temporary shutdown of vibratory pile driving or hammering;

(v) Revolution Wind must immediately cease pile driving or pneumatic hammering if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual, pile refusal, or pile instability; and

(vi) Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other marine mammal species.

(f) *UXO/MEC detonation*—(1) *General*. (i) Revolution Wind shall only detonate a maximum of 13 UXO/MECs, of varying sizes;

(ii) Upon encountering a UXO/MEC of concern, Revolution Wind may only resort to high-order removal (*i.e.*, detonation) if all other means of removal are impracticable; and

(iii) Revolution Wind must utilize a noise abatement system (*e.g.*, bubble curtain or similar noise abatement device) around all UXO/MEC detonations and operate that system in a manner that achieves the maximum noise attenuation levels practicable.

(2) *Seasonal and daily restrictions*. (i) Revolution Wind must not detonate UXOs/MECs from December 1 through April 31, annually; and

(ii) Revolution Wind must only detonate UXO/MECs during daylight hours.

(3) *PSO and PAM use.* (i) All visual PSOs and PAM operators used for the Revolution Wind project must meet the requirements and qualifications described in § 217.265(a) and (b), and (c), respectively, and as applicable to the specified activity; and

(ii) Revolution Wind must use at least 2 visual PSOs on each platform (*i.e.*, vessels, plane) and one acoustic PSO to monitor for marine mammals in the clearance zones prior to detonation. If the clearance zone is larger than 2 km (based on charge weight), Revolution Wind must deploy a secondary PSO vessel. If the clearance is larger than 5 km (based on charge weight), an aerial survey must be conducted.

(4) *Clearance zones*. (i) Revolution Wind must establish and implement clearance zones using both visual and acoustic monitoring, as described in the LOA;

(ii) Clearance zones must be fully visible for at least 60 minutes and all marine mammal(s) must be confirmed to be outside of the clearance zone for at least 30 minutes prior to detonation. PAM must also be conducted for at least 60 minutes prior to detonation and the zone must be acoustically cleared during this time; and

(iii) If a marine mammal is observed entering or within the clearance zone prior to denotation, the activity must be delayed. Detonation may only commence if all marine mammals have been confirmed to have voluntarily left the clearance zones and been visually confirmed to be beyond the clearance zone, or when 60 minutes have elapsed without any redetections for whales (including the North Atlantic right whale) or 15 minutes have elapsed without any redetections of delphinids, harbor porpoises, or seals.

(5) *Sound field verification.* (i) During each UXO/MEC detonation, Revolution Wind must empirically determine source levels (peak and cumulative sound exposure

level), the ranges to the isopleths corresponding to the Level A harassment and Level B harassment thresholds, and estimated transmission loss coefficient(s); and

(ii) If SFV measurements on any of the detonations indicate that the ranges to Level A harassment and Level B harassment thresholds are larger than those modeled, assuming 10-dB attenuation, Revolution Wind must modify the ranges, with approval from NMFS, and/or apply additional noise attenuation measures (*e.g.*, improve efficiency of bubble curtain(s), install an additional noise attenuation device) before the next detonation event.

(g) *HRG surveys*—(1) *General.* (i) All personnel with responsibilities for marine mammal monitoring must participate in joint, onboard briefings that would be led by the vessel operator and the Lead PSO, prior to the beginning of survey activities. The briefing must be repeated whenever new relevant personnel (*e.g.*, new PSOs, acoustic source operators, relevant crew) join the survey operation before work commences;

(ii) Revolution Wind must deactivate acoustic sources during periods where no data is being collected, except as determined to be necessary for testing. Unnecessary use of the acoustic source(s) is prohibited; and

(iii) Any large whale sighted by a PSO within 1 km of the boomer, sparker, or compressed high-intensity radiated pulse (CHIRP) that cannot be identified by species must be treated as if it were a North Atlantic right whale.

(2) *PSO use.* (i) Revolution Wind must use at least one PSO during daylight hours and two PSOs during nighttime operations, per vessel;

(ii) PSOs must establish and monitor the appropriate clearance and shutdown zones (*i.e.*, radial distances from the acoustic source in-use and not from the vessel); and

(iii) PSOs must begin visually monitoring 30 minutes prior to the initiation of the specified acoustic source (*i.e.*, ramp-up, if applicable), through 30 minutes after the use of the specified acoustic source has ceased.

(3) *Ramp-up.* (i) Any ramp-up activities of boomers, sparkers, and CHIRPs must only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to the initiation of survey activities using a specified acoustic source;

(ii) Prior to a ramp-up procedure starting, the operator must notify the Lead PSO of the planned start of the ramp-up. This notification time must not be less than 60 minutes prior to the planned ramp-up activities as all relevant PSOs must monitor the clearance zone for 30 minutes prior to the initiation of ramp-up; and

(iii) Prior to starting the survey and after receiving confirmation from the PSOs that the clearance zone is clear of any marine mammals, Revolution Wind must ramp-up sources to half power for 5 minutes and then proceed to full power, unless the source operates on a binary on/off switch in which case ramp-up is not feasible. Ramp-up activities would be delayed if a marine mammal(s) enters its respective shutdown zone. Ramp-up would only be reinitiated if the animal(s) has been observed exiting its respective shutdown zone or until additional time has elapsed with no further sighting. The specific time periods are 15 minutes for small odontocetes and seals, and 30 minutes for all other species.

(4) *Clearance and shutdown zones.* (i) Revolution Wind must establish and implement clearance zones as described in the LOA;

(ii) Revolution Wind must implement a 30 minute clearance period of the clearance zones immediately prior to the commencing of the survey or when there is more than a 30 minute break in survey activities and PSOs are not actively monitoring;

(iii) If a marine mammal is observed within a clearance zone during the clearance period, ramp-up would not be allowed to begin until the animal(s) has been observed voluntarily exiting its respective clearance zone or until a specific time period has elapsed with no further sighting. The specific time period is 15 minutes for small odontocetes and seals, and 30 minutes for all other species;

(iv) In any case when the clearance process has begun in conditions with good visibility, including via the use of night vision equipment (IR/thermal camera), and the Lead PSO has determined that the clearance zones are clear of marine mammals, survey operations would be allowed to commence (*i.e.*, no delay is required) despite periods of inclement weather and/or loss of daylight;

(v) Once the survey has commenced, Revolution Wind must shut down boomers, sparkers, and CHIRPs if a marine mammal enters a respective shutdown zone;

(vi) In cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.*, no shutdown is required) so long as no marine mammals have been detected;

(vii) The use of boomers, and sparkers, and CHIRPS would not be allowed to commence or resume until the animal(s) has been confirmed to have left the Level B harassment zone or until a full 15 minutes (for small odontocetes and seals) or 30 minutes (for all other marine mammals) have elapsed with no further sighting;

(viii) Revolution Wind must immediately shutdown any boomer, sparker, or CHIRP acoustic source if a marine mammal is sighted entering or within its respective shutdown zones. The shutdown requirement in this paragraph (g)(4)(viii) does not apply to small delphinids of the following genera: *Delphinus*, *Stenella*, *Lagenorhynchus,* and *Tursiops*. If there is uncertainty regarding the identification of a marine mammal species (*i.e.,* whether the observed marine mammal belongs to one of the delphinid genera for which shutdown is waived), the PSOs must use their best professional judgment in making the decision to call for a shutdown. Shutdown is required if a delphinid that belongs to a genus other than those specified here is detected in the shutdown zone;

(ix) If a boomer, sparker, or CHIRP is shut down for reasons other than mitigation (*e.g.*, mechanical difficulty) for less than 30 minutes, it would be allowed to be activated again without ramp-up only if:

(A) PSOs have maintained constant observation; and

(B) No additional detections of any marine mammal occurred within the respective shutdown zones; and

(x) If a boomer, sparker, or CHIRP was shut down for a period longer than 30 minutes, then all clearance and ramp-up procedures must be initiated.

(5) *Autonomous surface vehicle (ASV) use*. (i) The ASV must remain with 800 m (2,635 ft) of the primary vessel while conducting survey operations;

(ii) Two PSOs must be stationed on the mother vessel at the best vantage points to monitor the clearance and shutdown zones around the ASV;

(iii) At least one PSO must monitor the output of a thermal, high-definition camera installed on the mother vessel to monitor the field-of-view around the ASV using a hand-held tablet; and

(iv) During periods of reduced visibility (*e.g.*, darkness, rain, or fog), PSOs must use night-vision goggles with thermal clip-ons and a hand-held spotlight to monitor the clearance and shutdown zones around the ASV.

§ 217.275 Requirements for monitoring and reporting.

(a) *PSO qualifications.* Revolution Wind must employ qualified, trained visual and acoustic PSOs to conduct marine mammal monitoring during activities associated with construction. PSO requirements are as follows:

(1) Revolution Wind must use independent, dedicated, qualified PSOs, meaning that the PSOs must be employed by a third-party observer provider, must have no tasks other than to conduct observational effort, collect data, and communicate with and

instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements in this subpart.

(2) All PSOs must be approved by NMFS. Revolution Wind must submit PSO resumes for NMFS' review and approval at least 60 days prior to commencement of in-water construction activities requiring PSOs. Resumes must include dates of training and any prior NMFS approval, as well as dates and description of last experience, and must be accompanied by information documenting successful completion of an acceptable training course. NMFS shall be allowed three weeks to approve PSOs from the time that the necessary information is received by NMFS, after which PSOs meeting the minimum requirements in this paragraph (a) will automatically be considered approved.

(3) PSOs must have visual acuity in both eyes (with correction of vision being permissible) sufficient enough to discern moving targets on the water's surface with the ability to estimate the target size and distance (binocular use is allowable).

(4) All PSOs must be trained in marine mammal identification and behaviors and must be able to conduct field observations and collect data according to assigned protocols. Additionally, PSOs must have the ability to work with all required and relevant software and equipment necessary during observations.

(5) PSOs must have sufficient writing skills to document all observations, including but not limited to:

(i) The number and species of marine mammals observed;

(ii) The dates and times of when in-water construction activities were conducted;

(iii) The dates and time when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone; and

(iv) Marine mammal behavior.

(6) All PSOs must be able to communicate orally, by radio, or in-person with Revolution Wind project personnel.

(7) PSOs must have sufficient training, orientation, or experience with construction operations to provide for their own personal safety during observations.

(i) All PSOs must complete a Permits and Environmental Compliance Plan training and a two-day refresher session that will be held with the PSO provider and Project compliance representative(s) prior to the start of construction activities.

(ii) [Reserved]

(8) At least one PSO must have prior experience working as an observer. Other PSOs may substitute education (*i.e.*, degree in biological science or related field) or training for experience.

(9) One PSO for each activity (*i.e.*, foundation installation, cofferdam or casing pipe installation and removal, HRG surveys, UXO/MEC detonation) must be designated as the "Lead PSO". The Lead PSO must have a minimum of 90 days of at-sea experience working in an offshore environment and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience.

(10) At a minimum, at least one PSO located on each observation platform (either vessel-based or aerial-based) must have a minimum of 90 days of at-sea experience working in an offshore environment and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experiences. Any new and/or inexperienced PSOs would be paired with an experienced PSO.

(11) PSOs must monitor all clearance and shutdown zones prior to, during, and following impact pile driving, vibratory pile driving, pneumatic hammering, UXO/MEC detonations, and during HRG surveys that use boomers, sparkers, and CHIRPs (with specific monitoring durations described in paragraphs (b)(2)(iii), (b)(3)(iv), (b)(4)(ii), and

(b)(5)(iii) of this section. PSOs must also monitor the Level B harassment zones and document any marine mammals observed within these zones, to the extent practicable.

(12) PSOs must be located on the best available vantage point(s) on the primary vessel(s) (*i.e.*, pile driving vessel, UXO/MEC vessel, HRG survey vessel) and on other dedicated PSO vessels (*e.g.*, additional UXO/MEC vessels) or aerial platforms, as applicable and necessary, to allow them appropriate coverage of the entire visual shutdown zone(s), clearance zone(s), and as much of the Level B harassment zone as possible. These vantage points must maintain a safe work environment.

(13) Acoustic PSOs must complete specialized training for operating passive acoustic monitoring (PAM) systems and must demonstrate familiarity with the PAM system on which they must be working. PSOs may act as both acoustic and visual observers (but not simultaneously), so long as they demonstrate that their training and experience are sufficient to perform each task.

(b) *PSO requirements*—(1) *General.* (i) All PSOs must be located at the best vantage point(s) on the primary vessel, dedicated PSO vessels, and aerial platform in order to ensure 360° visual coverage of the entire clearance and shutdown zones around the vessels, and as much of the Level B harassment zone as possible;

(ii) During all observation periods, PSOs must use high magnification (25x) binoculars, standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. During impact pile driving and UXO/MEC detonation events, at least one PSO on the primary pile driving or UXO/MEC vessels must be equipped with Big Eye binoculars (*e.g.*, 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality. These must be pedestal mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation and PSO safety; and

(iii) PSOs must not exceed four consecutive watch hours on duty at any time, must have a two-hour (minimum) break between watches, and must not exceed a combined watch schedule of more than 12 hours in a 24-hour period.

(2) *WTG and OSS foundation installation.* (i) At least four PSOs must be actively observing marine mammals before, during, and after installation of foundation piles (monopiles). At least two PSOs must be stationed and observing on the pile driving vessel and at least two PSOs must be stationed on a secondary, PSO-dedicated vessel. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals with PAM before, during and after impact pile driving;

(ii) If PSOs cannot visually monitor the minimum visibility zone at all times using the equipment described in paragraph (b)(1)(ii) of this section, impact pile driving operations must not commence or must shutdown if they are currently active;

(iii) All PSOs, including PAM operators, must begin monitoring 60 minutes prior to pile driving, during, and for 30 minutes after an activity. The impact pile driving of monopiles must only commence when the minimum visibility zone is fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and the clearance zones are clear of marine mammals for at least 30 minutes, as determined by the Lead PSO, immediately prior to the initiation of impact pile driving;

(iv) For North Atlantic right whales, any visual or acoustic detection must trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be confirmed by species, it must be treated as if it were a North Atlantic right whale; and

(v) Following a shutdown, monopile installation must not recommence until the minimum visibility zone is fully visible and clear of marine mammals for 30 minutes.

(3) *Cofferdam or casing pipe installation and removal*. (i) At least two PSOs must be on active duty during all activities related to the installation and removal of cofferdams or casing pipes and goal post sheet piles;

(ii) These PSOs must be located at appropriate vantage points on the vibratory pile driving or pneumatic hammering platform or secondary platform in the immediate vicinity of the vibratory pile driving or pneumatic hammering platforms;

(iii) PSOs must ensure that there is appropriate visual coverage for the entire clearance zone and as much of the Level B harassment zone as possible; and

(iv) PSOs must monitor the clearance zone for the presence of marine mammals for 30 minutes before, throughout the installation of the sheet piles and casing pipes, and for 30 minutes after all vibratory pile driving or pneumatic hammering activities have ceased. Sheet pile or casing pipe installation shall only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of vibratory pile driving or pneumatic hammering.

(4) *UXO/MEC detonations*. (i) At least two PSOs must be on active duty on each observing platform (*i.e.*, vessel, plane) prior to, during, and after UXO/MEC detonations. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals with PAM before, during and after UXO/MEC detonations;

(ii) All PSOs, including PAM operators, must begin monitoring 60 minutes prior to UXO/MEC detonation, during detonation, and for 30 minutes after detonation; and

(iii) Revolution Wind must ensure that clearance zones are fully (100 percent) monitored.

(5) *HRG surveys.* (i) Between 4 and 6 PSOs must be present on every 24-hour survey vessel and 2 to 3 PSOs must be present on every 12-hour survey vessel. At least

one PSO must be on active duty during HRG surveys conducted during daylight and at least two PSOs must be on activity duty during HRG surveys conducted at night;

(ii) During periods of low visibility (*e.g.*, darkness, rain, fog, etc.), PSOs must use alternative technology (*i.e.*, infrared/thermal camera) to monitor the clearance and shutdown zones;

(iii) PSOs on HRG vessels must begin monitoring 30 minutes prior to activating boomers, sparkers, or CHIRPs, during use of these acoustic sources, and for 30 minutes after use of these acoustic sources has ceased;

(iv) Any observations of marine mammals must be communicated to PSOs on all nearby survey vessels during concurrent HRG surveys; and

(v) During daylight hours when survey equipment is not operating, Revolution Wind must ensure that visual PSOs conduct, as rotation schedules allow, observations for comparison of sighting rates and behavior with and without use of the specified acoustic sources. Off-effort PSO monitoring must be reflected in the monthly PSO monitoring reports.

(c) *PAM operator requirements*—(1) *General.* (i) PAM operators must have completed specialized training for operating PAM systems prior to the start of monitoring activities, including identification of species-specific mysticete vocalizations (*e.g.*, North Atlantic right whales);

(ii) During use of any real-time PAM system, at least one PAM operator must be designated to monitor each system by viewing data or data products that would be streamed in real-time or in near real-time to a computer workstation and monitor;

(iii) PAM operators may be located on a vessel or remotely on-shore but must have the appropriate equipment (*i.e.*, computer station equipped with a data collection software system (*i.e.*, Mysticetus or similar system) and acoustic data analysis software) available wherever they are stationed;

(iv) Visual PSOs must remain in contact with the PAM operator currently on duty regarding any animal detection that would be approaching or found within the applicable zones no matter where the PAM operator is stationed (*i.e.*, onshore or on a vessel);

(v) The PAM operator must inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the pile driving activity via the data collection software system (*i.e.*, Mysticetus or similar system) who will be responsible for requesting that the designated crewmember implement the necessary mitigation procedures (*i.e.*, delay or shutdown);

(vi) PAM operators must be on watch for a maximum of four consecutive hours, followed by a break of at least two hours between watches; and

(vii) A Passive Acoustic Monitoring Plan must be submitted to NMFS for review and approval at least 180 days prior to the planned start of monopile installation. The authorization to take marine mammals would be contingent upon NMFS' approval of the PAM Plan.

(2) *WTG and OSS foundation installation.* (i) Revolution Wind must use a minimum of one PAM operator before, during, and after impact pile driving activities. The PAM operator must assist visual PSOs in ensuring full coverage of the clearance and shutdown zones;

(ii) PAM operators must assist the visual PSOs in monitoring by conducting PAM activities 60 minutes prior to any impact pile driving, during, and after for 30 minutes for the appropriate size PAM clearance zone (dependent on season). The entire minimum visibility zone must be clear for at least 30 minutes, with no marine mammal detections within the visual or PAM clearance zones prior to the start of impact pile driving;

(iii) Any acoustic monitoring during low visibility conditions during the day would complement visual monitoring efforts and would cover an area of at least the Level B harassment zone around each monopile foundation;

(iv) Any visual or acoustic detection within the clearance zones must trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be identified by species, it must be treated as if it were a North Atlantic right whale. Following a shutdown, monopile installation shall not recommence until the minimum visibility zone is fully visible and clear of marine mammals for 30 minutes and no marine mammals have been detected acoustically within the PAM clearance zone for 30 minutes; and

(v) Revolution Wind must submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any pile driving. The plan must include final project design related to pile driving (*e.g.*, number and type of piles, hammer type, noise abatement systems, anticipated start date, etc.) and all information related to PAM PSO monitoring protocols for pile-driving and visual PSO protocols for all activities.

(3) *UXO/MEC detonation(s)*. (i) Revolution Wind must use a minimum of one PAM operator before, during, and after UXO/MEC detonations. The PAM operator must assist visual PSOs in ensuring full coverage of the clearance and shutdown zones;

(ii) PAM must be conducted for at least 60 minutes prior to detonation, during, and for 30 minutes after detonation;

(iii) The PAM operator must monitor to and beyond the clearance zone for large whales; and

(iv) Revolution Wind must prepare and submit a UXO/MEC and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any UXO/MEC detonations. The plan must include final project design and all information related to visual and PAM PSO monitoring protocols for UXO/MEC detonations.

(d) *Data collection and reporting.* (1) Prior to initiation of project activities, Revolution Wind must demonstrate in a report submitted to NMFS (at *itp.esch@noaa.gov* and *pr.itp.monitoringreports@noaa.gov*) that all required training for Revolution Wind personnel (including the vessel crews, vessel captains, PSOs, and PAM operators) has been completed.

(2) Revolution Wind must use a standardized reporting system from October 5, 2023 through October 4, 2028, the effective period of this subpart and the LOA. All data collected related to the Revolution Wind project must be recorded using industry-standard softwares (*e.g.*, Mysticetus or a similar software) that is installed on field laptops and/or tablets. For all monitoring efforts and marine mammal sightings, Revolution Wind must collect the following information and report it to NMFS:

(i) Date and time that monitored activity begins or ends;

(ii) Construction activities occurring during each observation period;

(iii) Watch status (*i.e.*, sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

(iv) PSO who sighted the animal;

(v) Time of sighting;

(vi) Weather parameters (*e.g.*, wind speed, percent cloud cover, visibility);

(vii) Water conditions (*e.g.*, sea state, tide state, water depth);

(viii) All marine mammal sightings, regardless of distance from the construction activity;

(ix) Species (or lowest possible taxonomic level possible);

(x) Pace of the animal(s);

(xi) Estimated number of animals (minimum/maximum/high/low/best);

(xii) Estimated number of animals by cohort (*e.g.*, adults, yearlings, juveniles, calves, group composition, etc.);

(xiii) Description (*i.e.*, as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

(xiv) Description of any marine mammal behavioral observations (*e.g.*, observed behaviors such as feeding or traveling) and observed changes in behavior, including an assessment of behavioral responses thought to have resulted from the specific activity;

(xv) Animal's closest distance and bearing from the pile being driven, UXO/MEC, or specified HRG equipment and estimated time entered or spent within the Level A harassment and/or Level B harassment zones;

(xvi) Construction activity at time of sighting (*e.g.*, vibratory installation/removal, impact pile driving, UXO/MEC detonation, construction survey), use of any noise attenuation device(s), and specific phase of activity (*e.g.*, ramp-up of HRG equipment, HRG acoustic source on/off, soft start for pile driving, active pile driving, post-UXO/MEC detonation, etc.);

(xvii) Marine mammal occurrence in Level A harassment or Level B harassment zones;

(xviii) Description of any mitigation-related action implemented, or mitigation-related actions called for but not implemented, in response to the sighting (*e.g.*, delay, shutdown, etc.) and time and location of the action; and

(xix) Other human activity in the area.

(3) For all real-time acoustic detections of marine mammals, the following must be recorded and included in weekly, monthly, annual, and final reports:

(i) Location of hydrophone (latitude & longitude; in Decimal Degrees) and site name;

(ii) Bottom depth and depth of recording unit (in meters);

(iii) Recorder (model & manufacturer) and platform type (*i.e.,* bottom-mounted, electric glider, etc.), and instrument ID of the hydrophone and recording platform (if applicable);

(iv) Time zone for sound files and recorded date/times in data and metadata (in relation to UTC. *i.e.*, EST time zone is UTC-5);

(v) Duration of recordings (start/end dates and times; in ISO 8601 format, yyyy-mm-ddTHH:MM:SS.sssZ);

(vi) Deployment/retrieval dates and times (in ISO 8601 format);

(vii) Recording schedule (must be continuous);

(viii) Hydrophone and recorder sensitivity (in dB *re. 1 μPa*);

(ix) Calibration curve for each recorder;

(x) Bandwidth/sampling rate (in Hz);

(xi) Sample bit-rate of recordings; and,

(xii) Detection range of equipment for relevant frequency bands (in meters).

(4) For each detection, the following information must be noted:

(i) Species identification (if possible);

(ii) Call type and number of calls (if known);

(iii) Temporal aspects of vocalization (date, time, duration, etc.; date times in ISO 8601 format);

(iv) Confidence of detection (detected, or possibly detected);

(v) Comparison with any concurrent visual sightings;

(vi) Location and/or directionality of call (if determined) relative to acoustic recorder or construction activities;

(vii) Location of recorder and construction activities at time of call;

(viii) Name and version of detection or sound analysis software used, with protocol reference;

(xi) Minimum and maximum frequencies viewed/monitored/used in detection (in Hz); and

(x) Name of PAM operator(s) on duty.

(5)(i) Revolution Wind must compile and submit weekly PSO, PAM, and sound field verification (SFV) reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that document the daily start and stop of all pile driving, HRG survey, or UXO/MEC detonation activities, the start and stop of associated observation periods by PSOs, details on the deployment of PSOs, a record of all detections of marine mammals (acoustic and visual), any mitigation actions (or if mitigation actions could not be taken, provide reasons why), and details on the noise abatement system(s) used and its performance. Weekly reports are due on Wednesday for the previous week (Sunday – Saturday) and must include the information required under this section. The weekly report will also identify which turbines become operational and when (a map must be provided). Once all foundation pile installation is completed, weekly reports are no longer required;

(ii) [Reserved]

(6)(i) Revolution Wind must compile and submit monthly reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that include a summary of all information in the weekly reports, including project activities carried out in the previous month, vessel transits (number, type of vessel, and route), number of piles installed, number of UXO/MEC detonations, all detections of marine mammals, and any mitigative action taken. Monthly reports are due on the 15th of the month for the previous month. The monthly report must also identify which turbines become operational and when (a map must be provided). Once foundation installation is complete, monthly reports are no longer required.

(ii) [Reserved]

(7)(i) Revolution Wind must submit an annual report to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) no later than 90 days following the end of a given calendar year. Revolution Wind must provide a final report within 30 days following resolution of comments on the draft report. The report must detail the following information and the information specified in paragraphs (d)(2)(i) through (xix), (d)(3)(i) through (xii), and (d)(4)(i) through (x) of this section:

(A) The total number of marine mammals of each species/stock detected and how many were within the designated Level A harassment and Level B harassment zones with comparison to authorized take of marine mammals for the associated activity type;

(B) Marine mammal detections and behavioral observations before, during, and after each activity;

(C) What mitigation measures were implemented (*i.e.*, number of shutdowns or clearance zone delays, etc.) or, if no mitigative actions was taken, why not;

(D) Operational details (*i.e.*, days of impact and vibratory pile driving, days/amount of HRG survey effort, total number and charge weights related to UXO/MEC detonations, etc.);

(E) SFV results;

(F) Any PAM systems used;

(G) The results, effectiveness, and which noise abatement systems were used during relevant activities (*i.e.*, impact pile driving, UXO/MEC detonation);

(H) Summarized information related to situational reporting; and

(I) Any other important information relevant to the Revolution Wind project, including additional information that may be identified through the adaptive management process.

(ii) The final annual report must be prepared and submitted within 30 calendar days following the receipt of any comments from NMFS on the draft report. If no comments are received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report must be considered final.

(8)(i) Revolution Wind must submit its draft final report to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) on all visual and acoustic monitoring conducted under the LOA within 90 calendar days of the completion of activities occurring under the LOA. A final report must be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 30 calendar days of NMFS' receipt of the draft report, the report shall be considered final.

(ii) [Reserved]

(9)(i) Revolution Wind must provide the initial results of the SFV measurements to NMFS in an interim report after each monopile foundation installation for the first three monopiles piles, and for each UXO/MEC detonation as soon as they are available, but no later than 48 hours after each installation or detonation. Revolution Wind must also provide interim reports on any subsequent SFV on foundation piles within 48 hours. The interim report must include hammer energies used during pile driving or UXO/MEC weight (including donor charge weight), peak sound pressure level (SPL_{pk}) and median, mean, maximum, and minimum root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}) and single strike sound exposure level (SEL_{ss}); and

(ii) The final results of SFV of monopile installations must be submitted as soon as possible, but no later than within 90 days following completion of impact pile driving of monopiles and UXO/MEC detonations. The final report must include, at minimum, the following:

(A) Peak sound pressure level (SPL_{pk}), root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}), single strike sound exposure level (SEL_{ss}), integration time for SPL_{rms}, spectrum, and 24-hour cumulative SEL extrapolated from measurements at specified distances (*e.g.*, 750 m). All these levels must be reported in the form of median, mean, maximum, and minimum. The SEL and SPL power spectral density and one-third octave band levels (usually calculated as decidecade band levels) at the receiver locations should be reported;

(B) The sound levels reported must be in median and linear average (*i.e.*, average in linear space), and in dB;

(C) A description of depth and sediment type, as documented in the Construction and Operation Plan, at the recording and pile driving locations;

(D) Hammer energies required for pile installation and the number of strikes per pile;

(E) Hydrophone equipment and methods (*i.e.*, recording device, bandwidth/sampling rate, distance from the pile where recordings were made; depth of recording device(s));

(F) Description of the SFV PAM hardware and software, including software version used, calibration data, bandwidth capability and sensitivity of hydrophone(s), any filters used in hardware or software, any limitations with the equipment, and other relevant information;

(G) Description of UXO/MEC, weight, including donor charge weight, and why detonation was necessary;

(H) Local environmental conditions, such as wind speed, transmission loss data collected on-site (or the sound velocity profile), baseline pre- and post-activity ambient sound levels (broadband and/or within frequencies of concern);

(I) Spatial configuration of the noise attenuation device(s) relative to the pile;

(J) The extents of the Level A harassment and Level B harassment zones; and

(K) A description of the noise abatement system and operational parameters (*e.g.*, bubble flow rate, distance deployed from the pile, etc.) and any action taken to adjust the noise abatement system.

(10) Specific situations encountered during the development of Revolution Wind shall require immediate reporting to be undertaken. These situations and the relevant procedures are described in paragraphs (d)(10)(i) through (v) of this section.

(i) If a North Atlantic right whale is observed at any time by PSOs or personnel on or in the vicinity of any project vessel, or during vessel transit, Revolution Wind must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System (866) 755-6622, through the WhaleAlert app (*https://www.whalealert.org/*), and to the U.S. Coast Guard via channel 16, as soon as feasible but no longer than 24 hours after the sighting. Information reported must include, at a minimum: time of sighting, location, and number of North Atlantic right whales observed.

(ii) When an observation of a marine mammal occurs during vessel transit, the following information must be recorded:

(A) Time, date, and location;

(B) The vessel's activity, heading, and speed;

(C) Sea state, water depth, and visibility;

(D) Marine mammal identification to the best of the observer's ability (*e.g.*, North Atlantic right whale, whale, dolphin, seal);

(E) Initial distance and bearing to marine mammal from vessel and closest point of approach; and

(F) Any avoidance measures taken in response to the marine mammal sighting.

(iii) If a North Atlantic right whale is detected via PAM, the date, time, location (*i.e.*, latitude and longitude of recorder) of the detection as well as the recording platform that had the detection must be reported to *nmfs.pacmdata@noaa.gov* as soon as feasible, but no longer than 24 hours after the detection. Full detection data and metadata must be submitted monthly on the 15th of every month for the previous month via the webform on the NMFS North Atlantic right whale Passive Acoustic Reporting System website (*https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates*).

(iv) In the event that the personnel involved in the activities defined in § 217.270(a) discover a stranded, entangled, injured, or dead marine mammal, Revolution Wind must immediately report the observation to the NMFS Office of Protected Resources (OPR), the NMFS Greater Atlantic Stranding Coordinator for the New England/Mid-Atlantic area (866-755-6622), and the U.S. Coast Guard within 24 hours. If the injury or death was caused by a project activity, Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

(B) Species identification (if known) or description of the animal(s) involved;

(C) Condition of the animal(s) (including carcass condition if the animal is dead);

(D) Observed behaviors of the animal(s), if alive;

(E) If available, photographs or video footage of the animal(s); and

(F) General circumstances under which the animal was discovered.

(v) In the event of a vessel strike of a marine mammal by any vessel associated with the Revolution Wind Offshore Wind Farm Project, Revolution Wind must immediately report the strike incident to the NMFS OPR and the GARFO within and no later than 24 hours. Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Species identification (if known) or description of the animal(s) involved;

(C) Vessel's speed leading up to and during the incident;

(D) Vessel's course/heading and what operations were being conducted (if applicable);

(E) Status of all sound sources in use;

(F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

(G) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

(H) Estimated size and length of animal that was struck;

(I) Description of the behavior of the marine mammal immediately preceding and following the strike;

(J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

(K) Estimated fate of the animal (*e.g.*, dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

(L) To the extent practicable, photographs or video footage of the animal(s).

§ 217.276 Letter of Authorization.

(a) To incidentally take marine mammals pursuant to this subpart, Revolution Wind must apply for and obtain an LOA.

(b) An LOA, unless suspended or revoked, may be effective for a period of time not to exceed October 4, 2028, the expiration date of this subpart.

(c) If an LOA expires prior to October 4, 2028, the expiration date of this subpart, Revolution Wind may apply for and obtain a renewal of the LOA.

(d) In the event of projected changes to the activity or to mitigation and monitoring measures required by an LOA, Revolution Wind must apply for and obtain a modification of the LOA as described in § 217.277.

(e) The LOA must set forth:

(1) Permissible methods of incidental taking;

(2) Means of effecting the least practicable adverse impact (*i.e.*, mitigation) on the species, its habitat, and on the availability of the species for subsistence uses; and

(3) Requirements for monitoring and reporting.

(f) Issuance of the LOA must be based on a determination that the level of taking must be consistent with the findings made for the total taking allowable under this subpart.

(g) Notice of issuance or denial of an LOA must be published in the **Federal Register** within 30 days of a determination.

§ 217.277 Modifications of Letter of Authorization.

(a) An LOA issued under §§ 217.272 and 217.276 or § 217.277 for the activity identified in § 217.270(a) shall be modified upon request by the applicant, provided that:

(1) The proposed specified activity and mitigation, monitoring, and reporting measures, as well as the anticipated impacts, are the same as those described and

analyzed for this subpart (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section); and

(2) NMFS determines that the mitigation, monitoring, and reporting measures required by the previous LOA under this subpart were implemented.

(b) For a LOA modification request by the applicant that include changes to the activity or the mitigation, monitoring, or reporting (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section) that do not change the findings made for this subpart or result in no more than a minor change in the total estimated number of takes (or distribution by species or years), NMFS may publish a notice of proposed LOA in the **Federal Register**, including the associated analysis of the change, and solicit public comment before issuing the LOA.

(c) An LOA issued under §§ 217.272 and 217.276 or § 217.277 for the activities identified in § 217.270(a) may be modified by NMFS under the following circumstances:

(1) *Adaptive management*. NMFS may modify (including augment) the existing mitigation, monitoring, or reporting measures (after consulting with Revolution Wind regarding the practicability of the modifications) if doing so creates a reasonable likelihood of more effectively accomplishing the goals of the mitigation and monitoring set forth in this subpart.

(i) Possible sources of data that could contribute to the decision to modify the mitigation, monitoring, or reporting measures in an LOA:

(A) Results from Revolution Wind's monitoring from the previous year(s);

(B) Results from other marine mammals and/or sound research or studies;

(C) Any information that reveals marine mammals may have been taken in a manner, extent or number not authorized by this subpart or subsequent LOA; and

(ii) If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS shall publish a notice of proposed LOA in the **Federal Register** and solicit public comment.

(2) *Emergencies*. If NMFS determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in the LOA issued pursuant to §§ 217.272 and 217.276 or § 217.277, an LOA may be modified without prior notice or opportunity for public comment. Notice would be published in the **Federal Register** within thirty days of the action.

§§ 217.278 - 217.279 [Reserved]

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